Electrical World

The consolidation of ELECTRICAL WORLD AND ENGINEER and AMERICAN ELECTRICIAN.

VOL. LV. NEW YORK, THURSDAY, MAY 19, 1910. No. 20.

PUBLISHED WEEKLY BY THE

McGraw Publishing Company

239 WEST THIRTY-NINTH STREET, NEW YORK

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TELEPHONE CALL: 4700 BRYANT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

EDITOR.....W. D. WEAVER
A. S. M'ALLISTER.....Associate Editor
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T. R. TALTAVALL.....Associate Editor
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TERMS OF SUBSCRIPTION.

United States, Cuba and Mexico, $3.00 per year; Canada, $4.50 per year. All Other Countries, $6.00 per year. Foreign subscriptions may be sent to our European office.

Requests for changes of address should be made one week in advance, giving *old* as well as new address. Date on wrapper indicates the month at the end of which subscription expires.

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Changes of advertising copy should reach this office ten days in advance of date of issue. New advertisements will be accepted up to noon of Monday of the week of issue.

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Entered as second-class matter at the post office at New York, N. Y.

The circulation of Electrical World for 1909 was 945,850. Of this issue 20,000 copies are printed.

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THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

Next week at St. Louis, with an elaborate program of work and a praiseworthy minimum of amusement, the National Electric Light Association will hold its thirty-third convention and celebrate its twenty-fifth anniversary. The event is one of unusual importance in the development of electrical industry in America, and the association is to be heartily congratulated on having reached its present position of strength and influence in so short a term of years. It must, indeed, be a source of great pleasure to those who have given their time and thought and effort freely to the association during the period, to see such a reward for their disinterested service, and to feel encouraged in their devotion and public spirit. Working through the association these men have been enabled to leave a deep imprint for good upon the art and industry, and they could have done it in no other way.

Beginning in 1885 with a total membership of only 71, the association at this moment numbers nearly 5500, and since last September has made the phenomenal, even sensational, gain of about 2000. This latter fact is in itself evidence of great vitality and of unsuspected powers of expansion. There are over 800 central stations and power transmission companies in membership. While the total number of "prospects" is about 5000, those still to come in are all small; the 820 operating companies which constitute the backbone of the membership representing over 90 per cent of the capitalization and earnings of the industry; and their actions and decisions in convention carry, therefore, irresistible weight. At the same time, the association would in some ways be better off if broader based with a larger number of smaller members, and these would be infinitely benefited by joining the ranks. The dues are so moderate they can form no obstacle, and it is to be hoped that in its next 25-year period the association may solve completely the problem of bringing these small companies into the fold. One adequate plan seems to be that of affiliating and creating State sections, so that the smaller company belongs to one and both for the same dues; but it is obvious that this plan will take time to carry out. Another process steadily at work is that of throwing the smaller companies into groups under one ownership or management, of which there are now some conspicuous examples, all within the association. But the "little fellow" will always be with the association in great numbers and he must be lined up for the general good.

The status of membership is still one of the association problems. At the outset, anybody operating a dynamo could come in, and the late George Porter used to tell with great glee how he brought in his carbon company in 1885 because it had a machine that ran one lamp for testing the "points." But manufacturing companies were soon, and wisely, debarred from control by loss of their votes; isolated plants were cut out; municipal plants were rendered ineligible and the association settled down to its present basis of active membership by oper-

ating companies owned by private capital. This will probably endure, but a new set of conditions are evidently looming up in the entrance of the State and geographic sections. Some of these include gas, water, railway, ice and telephone systems, and a new plan must be devised to take care of such of their members as are not specifically of the electric light class. Some State associations look with toleration on municipal plants or their managers and are averse to dropping them, while the new public service commissions are bringing forward talent that wishes to be identified in some way with the association.

The large statesmanship that has lifted the body to its present position will doubtless be equal again to the new conditions, but it will certainly be interesting to see how the thing works out. It is desirable that the extension of the State section system should go on, with the local constitutions in more or less harmony with that of the central body. Indeed, some farsighted observers predict a development of the Federal basis already laid, emphasized in the fact that every president of a section becomes a member of the association executive committee, which has thus passed insensibly into a senate or upper chamber in continuous session, as distinguished from the lower house, or convention, meeting once a year. Other shrewd students predict an overlapping of the various associations of the same character, and possibly in the end one great public utilities association, with individual or composite membership in its different groups, each standing for an industry. But all this will take time and the evolution cannot be forced.

The association has been successful lately in developing its company sections, and these now number over a score with not far short of 4000 members. This at once gives a very democratic base to the membership as a whole, being reinforced by over 500 from the ranks of the electrical manufacturing companies. As all these men get practically all the literature of the association, and as most of them attend regular local meetings to read and discuss papers, it is clear that a tremendous educational movement has been started, the full understanding of which is not yet. It seems to be a splendid thing for the men, in any event, and the companies by fostering it ought to derive incalculable benefit from having better trained employees. It would appear also that here is a means for cultivating the spirit of loyalty, while opening up the merit of a clearer path than it had before. So far, not enough emphasis has been laid on this part of the association work, in our judgment; and while there are a score of company sections, there ought to be 50 or 100 at least. The employee is the company to most of its customers, and the better employee he is made, the less will the company hear of complaints and poor service; the greater, too, will be its net profit.

For this reason we are glad to note that company-section work will have a session at St. Louis. Not less important is the creation of another section, that devoted to power transmission, which is to have one or two sessions, and which even if it had arranged for no papers or addresses would have found plenty of work ready to its hand. In a desultory way the association has considered and discussed these matters from time to time, but it was wise thus to treat them apart, and to plan for a regular section which will hereafter be as busy as those for accounting and for commercial questions. Both these sections have "made good" very decidedly, but the power transmission subjects are in some respects of broader and more vital interest to the association. Upon sources of cheap electrical energy in the future the welfare of the public and of the companies depends, and "power transmission" lies at the very heart of the matter. Were it not handicapped by its voluminous program of some 70 papers and reports to deal with, the association would find in this and other lines of new work greater opportunity to make history and begin auspiciously its next 25 years.

BACK TO MISSOURI.

It is now 17 years since the National Electric Light Association at its sixteenth convention found itself within the hospitable gates of St. Louis. During that period the growth of the central-station industry has been enormous and the changes in methods and apparatus have been of the most startling character. It is interesting to go back for a little and see what this sixteenth convention meant in relation to the changes which have followed it. The St. Louis convention of 1893 occurred at a veritable turning point in central-station practice. It was just at the critical moment when the modern alternating-current systems were beginning to force their way into practice, and when the era of large direct-coupled units was just dawning. The old days of the almost exclusive use of direct current for all motor and lighting purposes, and of central stations burdened with a multiplicity of small machines, had in no wise begun to pass away, but the handwriting was upon the wall.

St. Louis then had, under the management of President James I. Ayer, of the association, the largest single arc-lighting station in the world, operating something like 4000 lamps, a station visited with great interest by the delegates. It was a striking station, indeed, filled with belted arc machines, then considered of large capacity, and containing an amount of shafting and belts that conveyed an imposing idea of the magnitude of the enterprise. It was really a singularly well-constructed and wonderfully well-operated station for its period, to which its management might well point with pride. St. Louis also contained one of the pioneer large alternating stations, then looked upon as sinister strongholds of heterodoxy, in which Mr. Herbert A. Wagner was the chief iconoclast. It was a day when praise of the alternating system was still considered a dangerous heresy, and when Mr. Wagner modestly proclaimed that "it has now become possible to run arc lamps, as well as motors, on the alternating circuits, and I think that it is at last almost universally conceded that for most purposes the alternating current is more flexible than the direct," there was much dubious wagging of heads; and when he in addition explained that by means of a regulator the feeder pressure could be raised with a very small loss of energy, there were signs of open incredulity and the discussion of the paper was laid over until the arrival of Mr. Stillwell on the next day. In course of the discussion the question was seriously raised as to whether incandescent lamps would live as long on alternating current as on direct, and it was rather a consolation that the consensus of opinion seemed to indicate that there was no material difference. But there were signs that the "higher criticism" was already giving ground upon which the heretics could entrench themselves, and there were not wanting those who were looking far ahead beyond the then current practice. The following quotation from Mr. Edward

Weston's comments on the alternating system makes interesting reading 17 years after: "The systems, as established here, differ radically, in one respect, at least, from the systems established on the other side. Here, for the purpose of economy in the first cost, a very high rate of alternation has been adopted. From present experience, it seems as if this were a fundamental error, and that the error will be more apparent as the system has to be forced underground, which will be sooner or later. Whether the system, as it exists in this country today, will not be radically modified in the next few years so as to approach more closely the systems of Europe is a question; but I think it will. I think that will undoubtedly be done and the tendency will be toward a lower rate of alternation and a greater efficiency."

There were three papers dealing with the electrical transmission of energy, and each of the authors took advanced ground, although no one was then willing to speak with enthusiasm of transmission of energy over 40 or 50 miles, or of voltages much above 10,000, then the highest pressure in commercial use. There were signs, however, of vital activity in polyphase work, and the success of such systems for motor and lighting service and for use in connection with rotary converters was spoken of with an assurance that time has more than justified. Within a year the first practical polyphase energy-transmission plants were in successful operation and the thing was done. But other subjects in central station and apparatus occupied the mind of the sixteenth convention. A paper by Professor Forbes on "Thermal Storage for Central Stations" was received with great interest, although central-station men promptly proceeded to forget his advice. It is only within the present year that the question much discussed abroad in the early nineties, but little practiced, has received again serious attention, though in a much modified form. Of more direct and practical application was a paper on the then new experience of New York with underground conduits and conductors, and another on the preservation of poles and cross-arms by the impregnating process, which, had its good advice been more generally followed, would have saved a very pretty penny in depreciation for the central-station men of the country. Some further items of the proceedings, however, have now a distinctly archaic flavor; for instance, an elaborate eulogy on the then still-living "stopper" incandescent lamp.

It would be most inappropriate to dismiss the topics considered at this early St. Louis convention without mentioning the billiant and most interesting lecture of Mr. Tesla on high-frequency phenomena, then new to electrical science. Most of the experiments he showed had only an academic interest for the time being, and have produced as yet comparatively little impression upon the art, but it is worth noting that the lecturer laid down at considerable length the fundamental phenomena upon which wireless communications have been founded, and in particular showed and explained the very sources of electric oscillations now almost universally used in the wireless arc. As a matter of collateral interest it should be remembered that at the time of this convention the proposed Chicago and St. Louis high-speed electric railway was under discussion and the late Dr. Adams gave a dinner to a small group of delegates interested in transmission work, at which the subject was informally and fully discussed. The chances for success looked bright, and had it not been for the unfortunate panic a few months later it is altogether probably that the first long electric railway, and the first experiments on high speed with electric locomotives, would have graced our own country instead of awaiting development abroad.

The present convention, after these many years, brings with it the fulfillment of many of the promises of the last, and things beside of which even the boldest prophet 17 years back would have hesitated to speak with confidence. The small generators of 1893 have disappeared, have been replaced by the great direct-coupled engine-driven units, and these are now rapidly being pushed aside by the steam-turbine units, of which there was then hardly more than a covert hint. Luminous and flaming arcs, operated on constant-potential circuits, or from mercury rectifiers, are fast pushing aside everywhere the lamps that then made St. Louis notable, and in St. Louis itself have replaced them with a brilliancy scarce equaled elsewhere. The methods foreshadowed in Tesla's lecture have been applied to the production of oscillations transmitting intelligence well-nigh half way around the world, and the electrical transmission of energy then modestly exploited sweeps now at more than 100,000 volts over lines three or four times as long as the boldest dared then to predict for the near future. The world has moved and the electric industry with it, and St. Louis we shall find has kept splendidly up with the advance without failing in its ancient hospitality.

THE LUMINOUS EFFICIENCY OF INCANDESCENT LAMPS.

We know that the luminous efficiency of any incandescent-filament lamp increases as the working temperature of the filament is raised. For example, an incandescent lamp with a carbon filament operated at a dull red heat has a relatively low working temperature and a very low luminous efficiency. As we raise the temperature of the filament the candles per watt rise rapidly. Beyond a certain limit of temperature it is not safe to go, because the filament will melt and be destroyed. But long before the melting temperature is reached, the filament will vaporize, and its vapor, condensing upon the glass walls of the lamp, will blacken the same and reduce the luminous efficiency. In practice, therefore, the limit of temperature is that of rapid evaporation of the filament. If, then, a conducting substance can be found which will maintain a higher working temperature in an incandescing filament, without rapidly evaporating, the higher its luminous efficiency may be expected to be. In this sense, the hunt for a more economical filament in candle-power per watt is a hunt for a filament that will stand a higher temperature without evaporating rapidly. But this is not all. Different conducting substances radiate differently. The ideally satisfactory substance would be one which, when heated to the incandescing temperature, radiated no dark heat in the ultra-violet or in the infra-red region of the spectrum, but radiated all its heat in the visible region, especially near the yellow. No known metallic substance acts in this manner except in a small degree. There is commonly, however, a distinct diminution in radiative power in certain parts of the complete spectrum, and the radiation which exists is therefore relatively more active in certain favored parts. A lamp filament might, therefore, possess great luminous efficiency without rising in temperature if its selective radiation in the visible spectrum were sufficiently marked.

The article by Dr. W. W. Coblentz, printed elsewhere in this issue, is directed to the study of the selective radiation of metallic filaments based upon their reflectivities. A body which absorbs all the radiation that falls upon its surface, and reflects none, is called by physicists a "black body." An ungraphitized carbon filament closely approaches to a black body. The radiactive behavior of a black body at different temperatures is fairly well understood. The more a body reflects radiation, instead of absorbing it, the more it differs from a black body. The interesting fact is that those waves that it reflects, or absorbs with difficulty, it radiates feebly. It selects its radiation unfavorably to those wave lengths. Copper, for instance, reflects certain wave lengths particularly. Therefore, it radiates feebly in those wave lengths by comparison with a black body. Now, it does not necessarily follow that because a body reflects certain waves when cold it will continue to do so when hot. Nevertheless, the tendency to do so is well marked. Consequently, the article presents the reflective qualities of certain metals when cool, judging from the optical properties of mirrors made of those metals, as an index of selective radiation when heated.

TRANSMISSION LINE INSULATORS

Many interesting features connected with the design of insulators for high-tension transmission lines are discussed in an article by Mr. A. S. Watts on page 1294 in this issue, special attention being paid to the limit in voltage of the units as affected by the size and the limit in size as set by manufacturing considerations. Certain of the theoretical relations that could be applied to the proportioning of insulators for various voltages must be greatly modified to conform to the limits imposed by the mechanical characteristics of insulating materials and the permissible cost of construction. If the only requirement were that of providing increased dimensions with increase in the transmission e.m.f., all insulators could possess the same relative proportions and the weight would vary with the cube of the e.m.f. For example, if an 80,000-volt insulator weighs 8 lb., an insulator of exactly the same proportions designed for 40,000 volts should weigh 1 lb., one designed for 120,000 volts should weigh 27 lb., and one for 160,000 volts should weigh 64 lb. Although these values are within the range of possibility, the required mechanical strength dictates the use of somewhat larger insulators for the lower voltages, difficulties encountered in manufacturing suggest a change in proportion for the larger sizes, and consideration of costs places a limit upon the weight of material to be used in a single insulating unit. The last-mentioned limits have led investigators to turn from the older petticoated pin types toward other types to which the law of cubes is not applicable. A pin-type insulator, without petticoats, but containing surface corrugations, the weight of which should vary at a rate only slightly greater than the change in the e.m.f. is suggested by the author, who also describes the suspension type of insulator in which the weight and cost limitations have been removed. So long as only the petticoated pin type of insulator was available the maximum e.m.f. of transmission was reached at a value set by the insulators, but since the introduction of the suspension and corrugated insulators it can be stated that the transmission e.m.f. limitation is set by the loss occurring between wires at voltages below the values that the insulators can safely withstand. It is not improbable that this latter limitation will in some cases dictate the selection of aluminium cable rather than copper wire by reason of the increased size of the conductor.

CENTRAL-STATION DISTRIBUTION.

The recent field for central-station distribution has expanded so enormously as to pass quite outside the older practice of the distribution of energy. When a company is serving customers through an area of several hundred square miles, which is now by no means unusual, the distribution costs may rise to a somewhat formidable figure. These great central-station networks constitute the new problem in the economical distribution of energy toward the solution of which engineers are only yet beginning to feel their way. The tendency has been on the whole toward the centralization of energy production and distribution at high tension, after the manner of a transmission plant, to many substations scattered through the territory. There is no doubt that such an arrangement is productive of some wonderfully low generating costs, but it seems still an open question whether the total costs for energy delivered are properly kept down. The advent of the steam turbine has somewhat altered the situation with respect to the economy of the generating stations. With comparatively low installation costs and high efficiency in units of any reasonable size, it is easier to-day to split up a generating plant while retaining high efficiency than it ever has been before; consequently, there is something to be said now for the policy which does not put "all the eggs in one basket," so to speak, but subdivides the generating plant so as to diminish the now rapidly increasing average of distance of distribution in the system.

If, for example, a central station requires a generating equipment of 75,000 kw it becomes a debatable question, at least, whether it would not be wise to install two or three turbine plants with big units rather than to gather all the generators under a single roof. Data on energy costs with steam turbines under the best modern conditions are not yet complete enough to enable such a question to be answered offhand, yet there is a strong chance that such subdivision would save enough in the cost of the distributed energy to make up such small difference as may exist between generation, in, let us say, three 25,000-kw stations and one 75,000-kw station. If the separate plants were arranged on the ring system of transmission, the total number of units need not be any greater with the units separated than it would have to be were they all side by side, since for the purposes of reserve equipment a spare generator in any station would be entirely available. It would be far easier to keep everything going in case of an accident than it generally proves to be now. It is no difficult matter for a comparatively trivial occurrence, like trouble in a switchboard, to cause very serious misfortune on the circuits where they are all fed from a single power house. With a ring system fed from several stations the cutting out of even one complete station would not ordinarily be disastrous to the service. Theoretically, of course, one can segregate a generator, or set of generators, in a single station so that so far as the external circuits are concerned they would act as if they were miles apart, but practically this is seldom done.

In any event, the separated stations have the advantage of supplying energy at relatively short range and gaining a very

considerable measure of operating security. It is not always easy to find two or three locations equally well suited for a power station, yet in and about most cities it would be feasible to secure such locations for the extremely compact plants permitted by the turbo-generators. The number of substations on such an arrangement could be materially reduced to the advantage both of costs and operating expenses. We have seen no recent figures which bear squarely on the economics of such an arrangement. It would require, however, material advantage on the part of a station concentrated at a single point to neutralize the gain that could be made in average distribution losses by the use of separated stations. A difference in generating cost of 10 per cent as between one station and another looks big at first sight, but when the generating costs are down to ½ cent per kw-hour, or less, a loss of 0.05 of a cent per kw-hour is comparatively easy to make up in lower distribution costs and less substation expenses. At all events, the subject is one which needs to be thoroughly overhauled in the light of recent improvements in steam turbine costs and efficiencies.

IMPROVEMENT OF LOAD FACTOR.

Load factor is a term of sinister significance in most central stations. No manager really finds great comfort in inspection of the data in his own station nor will he derive any considerable consolation save that of feeling that there are others in the same plight from reading Mr. A. D. Adams' discussion of the average and maximum loads in a group of 20 stations of various capacity. Possibly the most interesting single feature of Mr. Adams' tabulation is the close similarity in load factor found in the stations investigated. Ignoring for the moment the small stations in which accidental circumstances have a disproportionately large effect, and taking into consideration only those of the list having an average load of 500 kw or more, the variation in load factor is singularly small, less than 7 per cent, the actual figures ranging from 26.6 to 33.2 per cent.

This is, in fact, the well-known difficulty of the electrical business, that there being no effective way of storing electricity as there is of storing gas, generating stations are compelled to work under uneconomical conditions. The real loss in economy does not always appear at first sight on account of the vicious habits of instituting comparisons on the basis of generating costs only. The investment charges due to very large margin of capacity above the average load, and the distribution charges are seldom subjected to the same close comparison. The public hears loud claims of the generation of energy at ½ cent per kw-hour and does not realize anything of these other charges which are just as real and sometimes a great deal more serious. That they are not more widely discussed is perhaps due to the fact that many stations are ashamed to acknowledge how great the investment charges and the distribution charges per kw-hour sold actually are. The best energy of most central-station operators is being devoted to raising the load factor, but with extremely indifferent success in most instances. The peak load looms up mountainous, and declines to be put down or reduced to the general level by any system of filling in. There are as many reputed remedies for bad load factor as there are for sea-sickness, and of about the same efficacy.

The main fact in the situation is that between 4 and 5 o'clock in the afternoon of the winter months a great many people need to use light who do not use electric energy in any form for the remainder of the 24 hours. The possible remedies for the unpleasant situation which exists are of the general nature of either "cuts" or "fills." The fill is naturally the more popular, but from the tendency of all load to run over into the afternoon lighting hours, ordinary fill, as by taking on motor load, helps indeed in the general average, but adds materially to the peak. As we have pointed out in these columns more than once, two classes of service generally neglected by most central stations, namely, heating and cooking and industrial lighting, have the merit of being for the most part off the peak and consequently help fill up the hollows. All motor and industrial load of every kind which is essentially night work also helps. After all these things, however, are taken into consideration, it still remains unpleasantly true that the filling process does not generally go on fast enough to compensate in any marked degree for the rising peak.

It is at least an open question whether a little judicious cutting in addition to filling will not help out in the net result of the year's business. There is a tendency in the larger city stations to take on greedily certain kinds of load which add very seriously to the peak and yet have to be taken, if at all, at a very low figure. Of course, when a territory has been fully exploited and the possibilities for filling exhausted, any increase in the load means increase in the peak. There is a question, however, whether it pays to increase the peak by load taken on at very low rates until all other classes of load have been pretty thoroughly assimilated. Taking, for example, the case of a big office building; its load is almost entirely peak load coming at the time when it involves the largest expense to the station. Furthermore, the hungry sales agent is very apt to do his best to take on that load at a price altogether too low, on the theory that if a really remunerative price is charged the building would put in an isolated plant. There are some reasons for thinking that a central station would do well at certain times in its career to let the unremunerative peak load be taken by an isolated plant if the customers concerned are not willing to pay a fair price for central-station service, and to devote more energy toward picking up load which will less increase the peak.

In the strenuous effort to avert the installation of an isolated plant that would be practically devoted to peak service only, energy is often sold at a price not greater than would be charged for motor load distributed throughout the day. So long as the policy is followed of taking on at almost any figure commercial load in order to discourage the installation of isolated plants, the peak may be expected to grow. Central-station managers do not like isolated plants in their territory and they cannot be blamed for the feeling. And yet a disadvantageous load for the station taken at too low a price is a rather expensive luxury in which to indulge. Nor does load strictly of this character tend so to decrease generating expense as to allow in general more economical service; on the contrary, it is the particular kind of load which tends to increase generating costs. One cannot expect to get unity load factor in a plant doing general service, but it certainly is feasible to improve present conditions, and particularly by cultivating all day and off-the-peak customers even at the price of freezing out some large peak consumers who in fact are much less profitable in reality than in appearance.

The Thirty-third Convention of the National Electric Light Association.

The program of exercises at the St. Louis convention of the National Electric Light Association was given in these pages last week. Since that time the third session of the Accounting Section has been arranged for Thursday at 10 a. m., as follows: Paper, "Meter Records," by Mr. Douglass Burnett; paper, "Keeping of Customers' Records," by Mr. R. F. Bonsall; paper, "The Workings of a Collection Bureau," by Mr. John C. Van Duyne; paper, "Accounting Symbols," by Mr. A. L. Holme.

There will be 17 working sessions of the convention. At these, 20 reports will be presented, 44 papers read, and 4 addresses made, a total of 68 items, not inclusive of incidental events. The papers and reports embrace about 1600 printed pages. The exhibit in the Coliseum will undoubtedly be very brilliant and successful. All the space has been taken up by 66 exhibitors and provision has had to be made for overflow exhibits. A plan of the exhibition hall and a list of the exhibitors with their locations are given elsewhere in this issue.

Details were given last week as to transportation, and Mr. Chas H. Hodskinson, the master of transportation, has issued a further circular of advice giving data as to trains, rates, etc., applying to different parts of the country. Two special cars have been chartered to convey the delegation from Denver and vicinity to the convention. The meeting is of especial interest to Denver electrical men, because Mr. F. W. Frueauff, vice-president of the Denver Gas & Electric Company, is president of the association. About 50 electrical men from Denver and vicinity have signified their intention of attending the convention.

Elaborate preparations have been made for the exhibition, which will be held in the Coliseum. The predominating colors in the decorations will be white and gold. In the lighting scheme free use will be made of tungsten lamps arranged in chandeliers.

The association reports a total membership on May 14 of 5370, being a gain of about 2200 or more since the last convention. As we go to press the advance registration for the convention is over 1700, which is more than 25 per cent in excess of advance registration for any previous convention held by the association.

With characteristic energy and enterprise the Commonwealth Edison Company of Chicago has decided to send 100 men from the Commonwealth Edison N. E. L. A. branch to attend next week's convention of the National Electric Light Association in St. Louis. The party will go in a special train over the Chicago & Alton, leaving Chicago about midnight on the night of May 24 and arriving in St. Louis in the morning. The Chicago delegation will spend the whole of May 25, which is "Anniversary Day," at the convention. The special train will be "parked" in the Union Station, and the delegates will leave their baggage on the train, which will be their headquarters during the convention.

The train will leave on the return trip late on the night of the 25th, arriving in Chicago on the morning of May 26. Of the party of 100 delegates from the Chicago branch, 20 will be nominated by President Samuel Insull, of the Commonwealth Edison Company, who is giving his personal attention to the project, in which he is much interested. The remaining 80 delegates will be elected by ballot by the Commonwealth Edison branch of the N. E. L. A. To be eligible, candidates must have been members in good standing before the special-train project was announced.

It is probable that this delegation of 100 from Chicago will be the largest to go in one party by special train to any electric-light convention for so long a trip as 290 miles, which is the distance separating Chicago and St. Louis. The Chicago company goes to the considerable expense involved in time and money in carrying out this enterprise to show its appreciation not only of the work of the National Electric Light Association, but also of its faithful employees who are members of the Chicago branch of the association.

Sanitary District to Furnish 10,000 Additional Street Arcs for Chicago.

By an arrangement finally agreed to on May 14, and which will be embodied in a formal contract as soon as the lawyers can draw up the papers, the Sanitary District of Chicago agrees to install 10,000 additional arc lamps for street lighting in the city of Chicago. At the present time the city has 12,200 street arc lamps, all supplied with electricity from the Sanitary District's 24,000-kw hydroelectric plant on the Chicago Drainage Canal at Lockport, Ill. This electrical energy is furnished to the arc circuits either through modern transformer substations or through the old generating stations equipped for operation by large electric motors receiving their energy from the Drainage Canal plant. The new extension will thus be nearly as large as the existing equipment, and the contract will mark the most important step forward in the history of street lighting in Chicago.

The new arc lamps will be of the 7-amp, alternating-current, series type, and they will be installed throughout the entire city as the result of a comprehensive plan laid out by Mr. William Carroll, city electrician, and Mr. E. B. Ellicott, electrical engineer of the Sanitary District. The Sanitary District will finance the plan, and to do so will issue serial bonds to be called in within seven years to an amount of about $1,250,000. A 10-year contract between the city and the District will be drawn up, and under it the latter agrees to install the new lamps at the rate of at least 3000 a year, all the lamps to be in place inside of three years from the date on which the plans are approved. After three years the contract can be modified on a year's notice from either party.

On its part the city agrees to pay for the electricity for the street-lighting service at the rate of $15 a horse-power per annum. The energy will be furnished on an average 12 hours a day, after sunset, every night in the year.

An important feature of the arrangement is that the Sanitary District will take over all transmission lines and substations of the city of Chicago. The city will, however, maintain the lamps and arc circuits. The Sanitary District is given the right to use these transmission lines in the daytime in supplying its private customers. On the other hand, the city has the right to the use of any of the transmission lines of the District at night, giving in many parts of the city duplicate lines to insure against breakdown in the street-lighting service.

Three-phase, 60-cycle energy is furnished. The transmission lines are operated at 12,000 volts, and electricity is to be furnished to the city's arc circuits at the proper voltage, probably 4250 volts. The electricity to be supplied under the $15 hp-year rate will be metered on the city's primary side at the substations.

The Sanitary District guarantees a continuity of operation of 99 per cent.

The Sanitary District agrees to operate all transmission lines and substations now erected, and for such service to charge the city $1 a year for each arc lamp so served. The city is to maintain and operate all arc circuits and arc lamps outside of those used in substation buildings.

In erecting the new transmission lines underground construction will be used in the central portion of the city, but overhead lines will be permitted in outlying districts.

It is promised that this notable extension of street lighting will make Chicago one of the best lighted cities in the country, and the arrangement will provide for the city's needs in this respect for at least a decade. The city secures nearly double its present equipment without financing the extension, and the Sanitary District obtains a night customer for nearly all its rated capacity and has also the use of the city's transmission lines during the day. Chicago has long had a municipal street-lighting system, but under the new arrangement it will simply buy its electricity at the substation. The central-station company has of late years supplied only a slight amount of electricity for street lighting in Chicago, and is possibly not unwilling that the output of the Sanitary District should be used for that purpose. Negotiations that have ended in the present

arrangement have been under way for several months. The Sanitary District was represented by a committee of trustees consisting of Messrs. Wallace G. Clarke, chairman; Henry F. Eidman and Thomas Healy. For the city a subcommittee of the finance committee of the City Council acted. It consisted of Aldermen Foreman, Sitts and Zimmer. Aldermen B. W. Snow, chairman of the finance committee, and President R. R. McCormick, of the Sanitary District, attended the conferences in an ex-officio capacity, while Messrs. Ellicott and Carroll were the technical advisers.

The Transmission of Photographs.

At a meeting of the New York Electrical Society held on May 11 Mr. T. Thorne Baker delivered an illustrated lecture on the transmission of photographs, both by wire and wirelessly, in which much information was given concerning the work of Professor Kohn. The speaker showed a portable equipment by means of which a photograph may be transmitted by wire. A half-tone photograph printed on lead foil is arranged to be revolved on a metal drum on which plays an iridium stylus. Every time the transmitter stylus comes in contact with a clear part of the metal foil, electricity flows to the receiver and a black mark is made upon chemical paper mounted on a drum revolving at the same rate. The transmitting instrument thus sends into the telegraph lines a series of electric impulses, the periods of duration of which are determined by the width of the lines composing the photograph. Each brief impulse reaching the paper at the receiving end makes a mark thereupon, and the combinations of these marks recompose the photographic image.

Mr. Baker also describes the form of apparatus in which use is made of selenium at the transmitting station and a light-interrupting device at the receiving station. This device consists of a fine silver wire covering a slit in a screen, the wire being in a strong magnetic field and acted upon by the impulses transmitted through the selenium cell from the sending station.

Prices of Electricity in Massachusetts in Relation to Cost of Living.

In connection with an inquiry by the special commission on the cost of living appointed by the Legislature of 1910, the Massachusetts Gas & Electric Light Commission, through its chairman, Hon. F. E. Barker, recently submitted three schedules showing the prices of gas, electricity and coke in all Massachusetts cities in 1890 and 1910. In its letter of inquiry the Commission on the Cost of Living stated that it desired to obtain information which would show the extent to which the cost of lighting, as one element in the family budget, had advanced in recent years. The evidence drawn from the records of the Massachusetts Gas & Electric Light Commission overwhelmingly shows that in Massachusetts public utility corporations supplying artificial illumination have generally reduced their rates by a percentage sufficient to save the communities which they serve large sums of money each year in proportion to the volume of illumination purchased, and that the small user as well as the large customer has benefitted by the decreases in rates.

In his letter, Chairman Barker points out that the prices for electricity are not the same for all customers in any company, but vary to some extent according to the conditions surrounding the supply. The prices given in the table are the maximum net prices charged for a supply by meter, now the method almost universally employed, although used by only a few companies as long ago as 1890. The prices given for 1890 are those established when the company began to sell by meter at a date soon after 1890. In comparing the prices given it is important to note further that owing to the improvement in incandescent lamps the same amount of energy which in 1890 supplied 18 lamps now supplies not only 20 of the same kind, but will yield from 2 to 2½ times as much candle power, though at a somewhat increased cost for the more efficient lamps.

The unit cost of electricity to the consumer has in many instances been cut in two, or more, during the 20 years spanned by the figures. An interesting phase of these price reductions, although not touched upon in the correspondence between the two commissions, is the fact that in a number of instances they have been brought about in connection with or in the face of physical and financial consolidations of public service properties, which have in general resulted in large reductions in rates and have in more senses than one lightened the burdens which rest upon the so-called "ultimate consumer."

PRICE OF ELECTRICITY IN MASSACHUSETTS CITIES, CENTS PER KW-HOUR.

City	1890	1910	City	1890	1910
Beverly	25	12	Medford	30	13
Boston	20 to 60	11	Melrose	30	13
Brockton	34	15	New Bedford	20	13.3
Cambridge	16.6	12	Newburyport	20	15
Chelsea	25	11	Newton	20	11
Everett	30	13	North Adams	20	13.5
Fall River	20	10.8	Northampton	20	15
Fitchburg	25	14.4	Pittsfield	24	17
Gloucester	20	16.2	Quincy	25	17
Haverhill	20	15	Salem	20	13
Holyoke (Municipal)	20	6	Somerville	20	11
Lawrence	20	14.4	Springfield	25	15
Lowell	16	10.8	Taunton	20	20
Lynn	25	12	Waltham	20	11
Malden	30	13	Woburn	20	11
Marlborough	30	15	Worcester	20	12

An Analysis of Cost of Telephone Service.

At the meeting of the City Council of Chicago on May 9, the city comptroller presented a report from Arthur Young & Company, certified accountants, and D. C. and W. B. Jackson, engineers, containing figures of the cost of telephone service for the year ended March 31, 1910. This report was presented in accordance with the ordinance passed Nov. 6, 1907, extending the franchise of the Chicago Telephone Company. It is an important document with a number of tables, and is of particular interest because it is probably the most careful analysis yet made of the cost of telephone service for the various classes of service, including the proportion of investment, taxes, depreciation, etc., to be apportioned to each class of service. The result of the investigation is rather surprising.

To show the cost of furnishing each class of telephone service provided by the Chicago Telephone Company the report gives three detailed statements: (A) A comparative statement by classes of service, showing for each the gross revenue, gross expenses, net revenue or losses, and the totals covering the portions as a whole; (B) a statement showing the details of the investment in property apportioned to each class of service; (C) a statement for each class of service showing the details of the expense figures submitted in Statement A.

There are two principal elements which go to determine the cost of furnishing telephone service. These are the investment in property and the expense of operating the property. Accepting the company's figures, it is considered that the average investment of the Chicago Telephone Company, for that portion of its plant in the city of Chicago, for the year ended March 31, 1910, was $23,250,166.15. The actual amount expended by the company on reconstruction and replacements for the year was $622,296. In place of this amount, the engineers and accountants have added to the expense of operating the property and spread against the various classes of service in the statements of the report the amount of $1,578,922.20, which is the depreciation for the year, computed on the basis of the depreciation rate table laid down by the Special Telephone Commission in its report to the city upon telephone matters in April, 1907.

It is pointed out that a large part of the plant has been recently installed and comparatively little of the plant has begun to cost the company anything yet on account of depreciation,

and up to the present time there has been no cost on account of reconstruction occasioned by the construction of street-railway subways; but it is contended that these costs are just as real as the costs for operators or maintenance of plant, and it is said to be just as important for the life of the company and the continued quality of its service that these costs are provided for, although the effect is not so immediately apparent.

The gist of the report is contained in the following paragraphs quoted from it verbatim:

The total expense to the telephone company for supplying the service throughout the city during the year ending March 31, 1910, excluding any return to the company on the investment, was	$6,973,785.58
The total revenue from this service under the rates prescribed by the city ordinance was	7,864,770.57
Showing a surplus of	$890,984.99

as representing the return to the company on the capital invested. This amounts to 3.83 per cent upon the investment in property used in the city telephone service, including working capital.

Assuming as the return on the investment the 5 per cent interest on the city proportion of bonds outstanding and the 8 per cent dividend on the city proportion of capital stock (which return figures at 7.74 per cent on the total investment in property used in the city telephone service, including working capital), we find the following result:

Surplus of revenue over expense before adding to expense any return on the investment, as above		$890,984.99
Deduct: 5 per cent interest on city proportion of bonds outstanding	$186,672.05	
8 per cent dividend on city proportnon of capital stock	1,612,846.46	
		1,799,518.51
Making a deficit of		$908,533.52

This amount is subject to a deduction representing the interest earned on the unexpended portion of the funds received from the sale of bonds, which we estimate amounts to not more than $75,000.

In conclusion the report says:

"Although the company has many millions of dollars invested in property in the city of Chicago, which is gradually depreciating, but has not yet reached the condition when it must be replaced by new apparatus, yet they are unable, from the income received from the service which they render by means of that property, to pay returns on their investment of a little less than 8 per cent; namely, 7.74 per cent, and set aside a reasonable sum toward the renewal of this apparatus when it becomes worn out or obsolete and for meeting the reconstruction expenses which will be imposed when the street railway subways are built. In other words, with the rates that are now in force, the company will reach a time when it will be impossible for it to provide the city adequate service on account of lack of funds to replace worn out or obsolete apparatus. It is also to be observed that the classes of service paid for at a fixed rate per year, without count of messages (including the commuted trunk circuits of the private branch exchanges), are uniformly unremunerative and in most instances do not pay for the current annual expenses and depreciation without any provision for return on the investment."

According to the provision of the ordinance the matter of readjusting the rates of the company is now under discussion, and while the report of the engineers and accountants was made for the city and to a city official, it is probable that the company, on the strength of it, will ask for increased rates. At the present rates, according to the report, with proper allowance for depreciation, and after paying 5 per cent on bonds and 8 per cent on stock, the Chicago Telephone Company, which has paid good dividends for many years, really faced a deficit of over $900,000 as the result of operations for the year ended March 31, 1910.

The tables accompanying the report are extremely interesting, but are too long to be given here. It is shown that in the prepaidnickel four-party line residence service the year's revenue was $22.772 for each station and the cost $22.75 for each station, leaving a net revenue of 2.2 cents per station, before adding to the cost any return to the company on capital invested. After adding the 5 per cent bond interest and the 8 per cent dividend apportioned to this class of service the cost became $28.641 per station, and the shortage was $428,063.95 on the 72,932 telephones in this class. This is nearly half of the total deficit shown in the report. The only classes of service showing a net revenue after allowing for the bond interest and dividends are the following: Measured single-party-line business service; prepaid nickel single-party-line public drug-store service; prepaid nickel single-party-line public service in approved locations; prepaid nickel single-party-line business service; prepaid nickel two-party-line business service (this is the most profitable); nickel trunked calls, mileage extension lines and private lines not connected to company's circuits.

Electrical Progress in Boston in 1909.

The annual report of Commissioner of Wires James E. Cole, of Boston, for the year ending Jan. 31, 1910, has just been published and contains a large amount of data of interest in connection with recent electrical progress in the city proper. Mr. Cole emphasizes the value of underground conduit construction as demonstrated in the blizzard of last Christmas. No fire has occurred during the year on account of wiring approved by the department. During the year about 2500 of the Gilbert type of enclosed arc lamps have been replaced in Boston by magnetite lamps and flaming arcs for street service, and 1200 new lamp poles suitable for the new styles have replaced the poles formerly in service. Tungsten lamps have to some degree replaced gasoline lamps, necessitating a considerable part of the increase in new pole settings during the year, 536 in all.

There are now 1,635,644 ft. of conduit installed in Boston, 10,376,795 ft. of single duct, 13,401,059 ft. of cable, 7457 manholes, 16,886 services, 599,709 ft. of Edison three-wire tube, and 628 Edison distribution boxes. About 50 per cent more of the above construction were installed in 1909 than in 1908. Wire sizes in use in cables vary from 600-pair telephone services to 2,000,000-circ. mil feeders for railway operation. The Edison Electric Illuminating Company installed 731 underground services during the year, and put down 294,623 ft. of cable in 18,956 ft. of conduit. The Boston Elevated Railway Company installed 24,194 ft. of conduit and 94,635 ft. of cable, and the New England Telephone & Telegraph Company installed 111,015 ft. of cable in 13,100 ft. of conduit. In the past 15 years over 59,000,000 ft. of wire, or about 11,000 miles, have been removed from overhead service in Boston.

The isolated plant capacity in Boston decreased slightly in 1909, the total kilowatt rating of the generators being 25,370 on Jan. 31, compared with 25,702 kw in 1909. The capacity of electric motors operated by isolated plants dropped from 14,986 hp in 1909 to 14,642 hp in 1910. The number of isolated plants increased from 319 to 322. The total rating of electric motors in Boston on Jan. 31, 1910, was estimated at 331,763 hp, including 271,449 hp in motors operating street and elevated cars.

Central-Station Output and Productive Economy.

The growth of central-station service during the past decade bears striking witness to the industrial economy of energy generation on a large scale. Small outputs and high prices are giving place to a greater volume of production at moderate rates per unit. The consumer obtains a better service than formerly and at a cost reduced in proportion to the amount of energy used; while on the other hand, the electric company

secures the benefits of a lower operating cost per kw-hour and enjoys a revenue which was practically non-existent in the earlier days. Electric service companies are demonstrating the profound economic truth that the larger the output from a given investment in equipment, the lower is the cost per unit produced, assuming reliable service and reasonably level costs of the raw material of power manufacture in bulk. Even in the face of changing prices for fuel, labor, water, and varying maintenance costs one can trace the benefits of an increased output.

It is in recognition of the advantages of a large output that central stations have of late devoted so much attention to the exploitation of new business. The days of waiting for the customer to originate a demand for electric service have departed. Admirable commercial organization for the sale of electric energy has superseded the old policy of taking what comes and devoting one's main attentions to the efficiency of station operation. Further progress is to be expected in the scientific study of applications of electricity, for as yet there is a scarcity of complete technical data in the files of power companies upon which propositions for new installations can safely be based. In the front rank of central-station advance are exceptional companies typified by the Narragansett organization of Providence, R. I., who are retaining old customers and securing new ones by exhaustive engineering analyses of the conditions surrounding each application of electricity.

To the engineer, economy of production can never lose interest to the commercial aspects of output sale. Hence it is profitable to examine a little more closely the results of policies of enlarged production in relation to the cost of manufacture. While it is not possible to determine the separate causes of improved operation in minute detail from the figures in hand, it is suggestive to note the general effect of increased output upon economy at the station busbar, spreading the service over yearly periods. Energy supplied off the peak and for long hours naturally produces the maximum influence toward reduced production cost, and here the motor load enters the situation as no other single factor has been able to do, enabling the company to utilize capacity which would otherwise stand idle, at a relatively insignificant cost compared with the expense of producing electric energy during the period of maximum demand upon the equipment.

Table I shows the comparative results of yearly operation in a central station whose total energy sales increased in the two years selected by about 63 per cent. The increase in the amount of energy generated was about 41 per cent, showing incidentally that the distribution system was worked more efficiently with the larger output.

TABLE I.—EFFECT OF INCREASED OUTPUT ON CENTRAL-STATION COSTS.

ITEM	First Year	Later Year
Station rating in kw	2,700	4,700
Kw-hr, delivered at busbars	4,601,230	6,484,140
" sold, total	3,490,970	5,706,241
" " motor service	1,009,587	2,514,122
Motor energy per cent. of total sales	28.6	44
Lb. fuel per kw-hr at busbar	3.37	3.24
Cost of fuel per ton, dollars	3.35	3.72
" " " kw-hr, cents	0.505	0.54
" " labor per kw-hr, cents	0.425	0.34
Total mfg. cost per kw-hr, cents	1.120	1.02

In the above case the gain in economy was not notably large as reflected in the total cost of manufacture per unit, although on the year's output it means a reduction of $6,484 in expenses. The company was handicapped by a sharp rise in the price of coal, so that the actual fuel cost per unit was a little larger in the later year. The reduction in the quantity of fuel required was a step in the right direction, looking at matters on the unit basis, and although the station payroll was based upon 16 men in the earlier and 20 men in the later year, the increased output effected a saving of nearly 0.1 cent per kw-hour here. The increase in the energy sales for motors was notable. Throughout the period covered, four years in actual duration, the station design remained substantially unchanged, with the exception of the addition of a 2000-kw unit of a type similar to those in the early plant. The equipment consisted in brief of alternators direct driven by vertical cross-compound engines of the condensing type, with steam supplied from hand-fired water-tube boilers.

Rapid growth in the motor service often has the effect of reducing costs perceptibly within a single year. Table II shows two consecutive years' results from a station of 1000 kw capacity. Here the increase in output was largely due to exploitation of motor service. As both coal and coke were burned, no fuel weights per unit of energy were available for comparative interpretation.

TABLE II.—EFFECT OF MOTOR LOAD ON STATION COSTS.

ITEM	First Year	Second Year
Station rating in kw	1,000	1,000
Kw-hr, delivered at busbars	1,916,145	2,835,687
" sold, total	1,449,209	2,107,726
" " motor service	574,468	1,185,417
Motor energy per cent of total sales	39.6	56.5
Cost of coal per ton, dollars	3.49	4.23
" " coke " " "	4.80	4.48
" " fuel " kw-hr, cents	0.783	0.632
" " labor " " "	0.435	0.31
Total mfg. cost per kw-hr, cents	1.4	1.07

The saving in unit cost in this instance amounted to about $9,400 in the second year, figuring upon that year's output at the old rate. Ten men operated the plant in each year, and the equipment was similar to that of the station outlined in Table I, but with smaller units in service. It is noteworthy that although the total production at the switchboard increased 48 per cent, the actual cost of operation at the station was only $3,500 greater in the second year. The total fuel bill was about $2,900 greater in the second year, but the labor account was only $450 more than at first, showing conclusively how far increases in output can be carried with a given plant and payroll volume before it becomes necessary to add to the equipment and personnel. The secret of this company's success in cutting its unit costs in the face of so large an increase in output was unquestionably the cultivation of its motor load.

Table III illustrates the improvement in station economy which followed the expansion of the load in a very small station of about 600 kw rating, the price of fuel remaining nearly the same throughout a four-year period. In the fourth year the general design of the station had undergone little change, and there were still in use a combination of belted and direct-connected units which characterized the earlier installation.

TABLE III.—IMPROVEMENT IN STATION ECONOMY DUE TO INCREASE IN LOAD.

ITEM	First Year	Fourth Year
Station rating in kw	540	630
Kw-hr, delivered at busbars	420,520	730,458
" sold, total	409,730	549,620
" " motor service	198,990	230,293
Motor energy per cent of total sales	48.5	41.5
Lb. coal per kw-hr at busbar	8.4	5
Cost of coal per ton, dollars	4.05	4.15
" " " " kw-hr, cents	1.52	0.93
" " labor " " "	0.89	0.685
Total mfg. cost per kw-hr, cents	2.78	1.8

Although these costs are far above the limits of good practice with modern equipment they illustrate how development of business will help even a small and antiquated station to operate less expensively. In the case at hand the results of the two years' operation show that the distributing system was not doing all that might have been expected from it; that the motor load coming naturally off the peak was not increasing at a sufficiently rapid rate to produce the results readily within grasp; and that a modernized station is the solution of the production problem in this community. The destruction of this station by fire about a year ago, the rebuilding of the plant along modern lines with direct-connected condensing units, flexibly piped for regular and emergency operation, and the extension of the motor load at the present time are bringing the unit cost close to 1 cent per kw-hour.

In steam-driven central stations increase of output tends naturally toward economy, regardless of whether the plants are equipped with simple turbine apparatus, reciprocating engines or a combination of both. Table IV shows the results of two

years' operations in a combined engine and turbine plant of about 5700 kw rating. In this instance the conditions are somewhat complicated by the policy of the company in regard to the improvement of its station. The earlier equipment contained a number of belted units of small size which were used largely on the peak load, but these were relatively unimportant in handling the total load. The larger engine and turbine units were used for the greater portion of the time, so that a considerable part of the improvement can fairly be charged to the increased production.

TABLE IV.—EFFECT OF INCREASE IN LOAD ON STATION COSTS.

Item	First Year	Later Year
Station rating in kw	5,000	5,700
Kw-hr. delivered at busbars	6,052,518	8,800,828
" sold	5,091,261	7,094,723
" " motor service	2,107,214	2,977,674
Motor energy per cent of total sales	41	42
Cost of fuel per kw-hr, cents	0.634	0.42
" " labor " " "	0.302	0.28
Total mfg. cost per kw-hr, cents	1.42	0.99

In the earlier year the company burned coal costing $3.17 per ton, coke, breeze and tar. In the later year the fuel was straight coal, costing $3.05 per ton. The labor cost did not drop off in the case of this company to the extent that obtained in previous instances, as the number of employees and also the wages were increased. The saving on the output of the later year was about $38,000, comparing with the station performance of the earlier 12 months.

These four examples drawn from recent central-station practice might be further extended in illustration of the benefits of large output in relation to economy, but enough has been given to indicate the effectiveness of growing loads in improving plant efficiency under widely varied and changing conditions. This situation is by no means peculiar to the central-station industry, but carries much significance to industrial power plants generally. With a given capacity in equipment, additional output below overload limits which endanger the service reliability of the apparatus in general tends to cut down the cost of production, despite the widespread impression that the highest efficiency of most modern equipment is reached at normal outputs. The plant, as a whole, must be considered in all analyses of efficiency between the fuel supply and the outgoing lines which aim to better conditions of operation. In general, equipment of recent design operates with lower proportional losses at and above normal rating than exist at underloads. One of the most trying situations which the average central station has to face is the fluctuation in the demand of its community for its product. Diversified enlargement of output spreads the demand over wider time intervals and flattens the load curve. Thus, the advantages in revenue secured from larger outputs are supplemented by savings in plant operation which doubly justify active efforts to escape the penalties of supplying energy at loads far beneath the normal station rating.

Meeting of the Empire State Gas and Electric Association.

A meeting of the Empire State Gas & Electric Association was held in the assembly room of the Yates Hotel, Syracuse, N. Y., on May 11. In the absence of the president, Mr. Charles R. Huntley, on account of illness, the first vice-president, Mr. M. J. Brayton, presided. After the meeting was called to order, Mr. James C. DeLong, vice-president and general manager of the Syracuse Lighting Company, extended a cordial invitation to all of the delegates to lunch with him at the Century Club. He also stated that a number of representatives of his company were present and would be glad to show any of the delegates through the company's plants. As the morning session was to be devoted to questions of particular interest to the gas men, a number of the electrical men availed themselves of this opportunity.

Mr. Charles H. B. Chapin, the secretary, read portions of a report which had been prepared by the Joint Committee on Calorimetry representing the gas companies of the State and the Public Service Commission of the Second District, appointed at the conference of gas companies with the commission on Feb. 1, 1910. Numerous questions were asked as to the status of this question, and were answered by either the secretary or Mr. DeLong, who is a member of the committee. It was stated that the report would probably be distributed to the gas companies within a comparatively short time. The consideration of this report occupied practically all of the morning session.

At the close of this session the delegates went to the Century Club, in accordance with Mr. DeLong's invitation, and were met by those who had been visiting the company's plants during the morning.

At 3 o'clock the afternoon session was called to order in the Yates Hotel. Among the subjects discussed at this session were the following:

Methods of soliciting new business by combined gas and electric companies, including the advantages and disadvantages of having separate solicitors in the gas and electric departments.

Competition of gasoline motors with both gas engines and electric motors.

Twenty-five-cycle lighting with different styles of lamps and whether such lighting was proving satisfactory where in use at present.

Methods employed to prevent permanently losing customers through non-payment cut-offs.

Methods employed for forestalling complaints of high bills by notifying customers in advance whenever possible reasons for increase or calling their attention to the unusually long bill period.

After the meeting several of the delegates stated that they proposed putting into effect at once several of the methods described by representatives of other companies.

Before adjournment a vote of thanks was extended to the Syracuse Lighting Company for its entertainment. A number of the delegates remained during the evening in order to see the street lighting and illumination.

The informal meetings of the association will be continued from time to time in different parts of the State. It is felt that benefit is derived, not only from the discussion in the meetings, but also through the opportunity afforded to the representatives of different companies to become acquainted and to exchange ideas.

A. I. E. E. Meeting in San Francisco.

A meeting of the American Institute of Electrical Engineers under the auspices of the high-tension committee was held in San Francisco on May 5, 6 and 7, the sessions being held in the Home Telephone Building. The meeting was a very successful one, both from the attendance, which was about 200, and from the great interest taken in the papers which were presented. Among those from the East in attendance were President L. B. Stillwell, Secretary Ralph W. Pope and Mr. S. I. Rhodes, of New York.

The following papers were presented: "Parallel Operation of Three-Phase Generators with Interconnected Neutrals," by Mr. S. I. Rhodes; "The Developed High-Tension Network of a General Power System," by Mr. P. M. Downing; "Observations of Harmonics in Current and Voltage Wave Shapes of Transformers," by Mr. J. J. Frank; "Hydroelectric Developments and Irrigation," by Mr. John Coffee Hays; "Transmission Line Crossings of Railroad Rights-of-Way," by Mr. A. H. Babcock; "Emergency Stations for Service in Connection with Hydroelectric Transmission Plants Under Pacific Coast Conditions," by Mr. A. M. Hunt. Interesting discussions were held on all of the papers.

In addition to the entertainment of the ladies at luncheons, theater parties and sightseeing trips, the social and special features for the members included a banquet at the Poodle Dog, Friday evening, luncheon at the Cliff House, Saturday, with special trips to the city plants of the Pacific Gas & Electric Company, the City Electric Company and the United Railroads.

On Saturday afternoon a special visit was made to Stanford University through the courtesy of Prof. Harris J. Ryan, member of the high-tension committee, where a demonstration was made of the cathode ray power indicator, the corona voltmeter and the cathode ray oscillograph. On Saturday, May 8, several members left for a visit to the De Sabla and Folsom hydroelectric power stations of the Pacific Gas & Electric Company, the Big Bend station and Brighton substation of the Great Western Power Company and the Natomas Consolidated gold dredgers near Folsom.

The local committee of arrangements consisted of Prof. Harris J. Ryan, chairman; Messrs. A. M. Hunt, S. J. McMeen, Geo. R. Murphy and John Coffee Hays.

OPERATION OF GENERATORS WITH INTERCONNECTED NEUTRALS.

Mr. George I. Rhodes presented a paper dealing with the triple-frequency e.m.f. produced between the "neutral" points of two star-connected three-phase generators when operating in parallel. The triple-frequency e.m.f. is attributable to the variation of the field flux from a sinusoidal space distribution around the air-gap. The author showed mathematically that even when two exactly similar alternators are joined in parallel there may be considerable current in the neutral circuit if the load on the one machine differs from that on the other as may be the case during the synchronizing period. From his analysis the author concludes that alternators as usually designed and built are not suited for parallel operation with their neutrals interconnected. The difficulty is greatly increased during the operation of synchronizing, making successful connections more or less uncertain. He remarked that it is perfectly feasible to build generators which will operate properly and when such machines are needed it should be specified that their neutral potentials should not exceed, say, 1 per cent of the excitation e.m.f.

INTERCONNECTED TRANSMISSION SYSTEMS.

Mr. Downing's paper dealt with the interconnected transmission systems supplying energy for the Pacific Gas & Electric Company at San Francisco. This company purchases energy from four independent companies, operates 10 plants of its own and has two steam and one gas-engine stations as reserve. The four companies, namely, the Great Western Power Company, the Sierra & San Francisco Power Company, the Northern California Power Company and the Snow Mountain Power Company, deliver energy at the common electromotive force and frequency of 60,000 volts and 60 cycles, the last three directly from their transmission lines and the first one through reducing transformers from its 100,000-volt line. In the systems interconnected with the systems of the Pacific Gas & Electric Company there are a totzl of 150 miles of 100,000-volt lines, 1390 miles of 60,000-volt lines and 380 miles of 20,000-volt lines. It has been found that the paralleling of the widely separated stations has not presented difficulties even so great as those encountered in paralleling generators in one station.

The governing and the division of load between the different stations has not proved a difficult problem. Each station assumes its allotted portion of load and makes no attempt whatever to govern, the speed control being left entirely to one station. The governing is not limited to any one particular station, but it can be done at any station having sufficient equipment to handle the fluctuations of load.

For the purpose of avoiding any confusion all details of the operation of the various plants are in absolute charge of one man, known as the "load dispatcher," who is at all times in direct telephonic communication with every part of the system. In his office is a board showing diagramatically every generating station, transmission line and substation in the system, together with dummy switches representing every air switch and oil switch and the exact position of these switches. The station generators are connected directly to the line without circuit-breaking devices of any kind. Immediately on the slightest indication of line trouble the system is subdivided, leaving different sections or districts to receive energy from different sources. Generally the operators succeed in separating the sections without more than a temporary drop in voltage.

HARMONICS IN TRANSFORMER WAVE SHAPES.

A paper by Mr. John J. Frank gave a record of an extended investigation of the wave shapes of voltage and current in transformers under different conditions of operation. By means of an oscillograph the author found that when the impressed e.m.f. wave is truly sinusoidal the exciting current contains many harmonics of which the third and fifth are most prominent. The amplitude of the third harmonic increases with the density in the core, the limiting value being dependent, to a certain extent, on the value of the other higher harmonics also present in the current wave. When several transformers are connected in a group, such as when operated in a three-phase system, the variation in the permeability of the cores may produce considerable unbalance in the currents or electromotive forces. The author concludes that in any distributing system disturbances of current and potential are to be expected unless provision is made to maintain sine potential across the individual transformers.

HYDROELECTRIC ENERGY FOR IRRIGATION.

The paper by Mr. John Coffee Hays was devoted for the most part to a description of the plant of the Mount Whitney Power Company, and the situation is discussed on the basis of tests and experience gained in the operation of that plant, which is probably the only power plant in the United States that depends for most of its load upon irrigation pumping.

Mr. Hays laid great emphasis on the fact that an irrigation pumping load must develop gradually. On account of this gradual and steady increase in load the plant should be so designed as to keep the first cost down, especially while the load is relatively small. The water may be conducted in wooden flumes, the line construction may employ wooden poles with maximum spans, the substation apparatus may be housed in corrugated iron shelters, and in every way the initial investment can be kept down. Reliability and continuity of service in irrigation service are not of the same order of importance as in railway, industrial or lighting service, and insurance of these two factors can be sacrificed to a certain extent by using wood instead of more permanent materials, by reduction of the switchboard equipment to a minimum; by using a single transmission line, connected to form a ring, thus gaining in flexibility without the expense of duplicate lines, and by many other expedients not considered good practice in plant providing general public service.

The author says that in order to develop an irrigation business of any size the plans must be laid far in advance and the character of the territory studiously investigated. The electric company must be wide awake to the value and possibilities of irrigation, because its campaign will consist largely in educating farmers in ways and means of increasing the earning power of their land by irrigation.

Arguments of the author tend to establish the fact that ground-water irrigation is not only better, but often more economical than the gravity system.

The author's experience in California shows that the average depth of irrigation is about 2 ft. per season and that it varies with the locality and character of the crop and soil all the way from 1.2 ft. to 8 or 10 ft.

The rates charged for service by the author's company are of two kinds: 1. A flat rate of $50 per year per horsepower of maximum demand. 2. A flat rate of $25 per horsepower for the period between Feb. 1 and July 31, and a meter rate of 3 cents per kw-hour with a maximum charge of $1 per month per horsepower for the remainder of the year. All the contracts include the following provisions: 1. All contracts are acknowledged before a notary public and recorded. 2. All contracts are an absolute lien on the property of the consumer, the property being accurately described in the contract. 3. The consumer grants the company a right of way over any part of the property described. 4. The use of the energy is limited to the land described in the contract. 5. All delinquent accounts bear interest at the rate of 1 per cent per month, compounded monthly. 6. The minimum charge under the flat-rate contracts is for 75 per cent of the rated capacity of the motor.

TRANSMISSION LINE CROSSINGS.

A paper by Mr. A. H. Babcock outlined certain specifications for transmission crossings of railroad rights-of-way that are now under discussion between the transmission and railroad companies. The specifications were drawn so as to insure the construction of the transmission line with maximum factor of safety both in the crossing span and also in each of the adjacent spans, so that nothing short of a general catastrophe shall bring the line into dangerous proximity to the railroad right-of-way. The author remarked that the transmission and railroad interests are working in harmonious conjunction to devise an economical mechanical and electrical construction for the crossing spans, so much more secure than that of the transmission line elsewhere, that if ever failure occurs it must be at some other point.

AUXILIARY GENERATING STATIONS.

In the paper by Mr. A. M. Hunt a comparison was made between a station having generators driven by gas engines and one in which steam-driven turbo-generators are used.

As a basis of comparison, Mr. Hunt assumed a station designed for continuous operation at 25,000 kw, and a power factor of 85 per cent. The fuel used in each case would be crude petroleum. The gas-engine station, to meet the requirements, would contain 12 2085-kw units, which with the necessary gas-producer equipment and buildings would cost $130 per kilowatt. The steam-driven turbo-generator station would contain two 12,500-kw units which would cost $60 per kilowatt, including the whole steaming equipment and buildings. The author stated that the steam-turbine plant could be started from rest and placed in service equally as promptly as could the gas-engine station. The stand-by charges per year would amount to $14.50 for the gas-engine plant and $6.64 for the steam-turbine plant, while the costs for fuel would be practically identical in the two cases.

Modern Lamps and Lighting Systems.

The meeting of the American Institute of Electrical Engineers, at New York on May 17, was held under the auspices of the electric lighting committee, two papers relating to modern lamps and lighting systems being presented at that time.

METAL-FILAMENT LAMPS.

In a paper on metal-filament lamps, Mr. John W. Howell stated that the fears of central station managers that their income would be reduced by the introduction of tungsten lamps have not been realized; on the contrary, their income has been increased by the rapid extension of their business into new fields which were opened by the superiority of the new lamps, and by the availability of the larger sizes of lamps, which, with the carbon filaments, were not successful.

Tungsten is one of the heaviest metals known, having a specific gravity of about 20. Its melting point is over 3000 deg. C., which is higher than that of any other known metal. Its radiation characteristics are very favorable for its use as a light-giving source, for it possesses selective radiation, the proportion of its total radiations which are in the visible spectrum being greater than that of other substances which are considered normal. The superior efficiency of tungsten lamps is due to certain physical characteristics of the metal tungsten; namely, its ability to remain stable at a very high temperature, and its ability when at this high temperature to emit more than the normal proportion of its radiations in the visible spectrum.

Tungsten has other interesting characteristics; while its melting point is very high it oxidizes at a very low temperature (about 300 deg. C.). It also softens at a very low temperature, and filaments which are easily broken when cold can be bent permanently into any desired shape at a temperature below the oxidizing point. The specific resistance cold of carbon is 800 times that of tungsten, and at normal working temperature it is 33 times that of tungsten. The cold resistance of a tungsten filament is only one-twelfth the resistance at normal operating temperature, consequently when first connected to the circuit the current is for an instant much greater than the normal current. This excessive current is of sufficient duration to cause an instantaneous rise in candle-power, which is higher than the normal candle-power; this effect has been called "overshooting." In a tungsten filament an increase in voltage is accompanied with an increase in resistance, while in a carbon filament the resistance remains practically constant. An increase of 3.7 per cent in voltage will halve the life of a carbon lamp, while it requires an increase of 5.2 per cent to halve the life of a tungsten lamp.

From the results of experiments made over 20 years ago it was deduced that the lives of lamps at different candle-powers varied inversely as the 3.65 power of the candle-power. These experiments were made on lamps with untreated bamboo filaments. When treated carbon filaments came into use a great many experiments were made to determine whether or not this same exponent was true for them. The conclusion was that the same exponent should be used for both types. Again when metal filament lamps became established the same question arose, and now comparisons have been made upon large numbers of lamps at different candle-powers, each comparison being made between lamps of the same type, and the result of these comparisons indicate that the same exponent which is used for carbon lamps is also the proper one for lamps with metal filaments. The relation between life and watts or watts per candle-power is very nearly the same for all different types of lamps, because the relation of candle-power and watts per candle-power is nearly the same for all types.

All tests conducted for comparing different types of lamps should be made on the basis of their spherical candle-powers, for the ratios between the spherical and horizontal candle-powers of lamps is sufficiently different to introduce very considerable errors if they are compared on the basis of their horizontal candle-powers, as is quite generally done. Tungsten lamps of the ordinary 110-volt type have a spherical candle-power which is 0.785 of their horizontal candle-power, and when taking 1.25 watts per candle on the basis of their horizontal candle-power are taking 1.59 watts per candle on the basis of their spherical candle-power. Metal-filament lamps last so long when tested as 1.25 watts per candle, which is their normal rating, that it is customary to test them at higher efficiencies. Tests at 1 watt per candle are usually made; many tests at 0.75 watt per candle are made when quick results are desired, and daily factory tests, outside the lift-test department, at double voltage, are very valuable when properly interpreted.

Tungsten filaments as generally made to-day consist of an agglomeration of fine particles of metallic tungsten. These particles are sintered or welded together by raising the filaments to a very high temperature in a reducing atmosphere. The sintering is made as complete as the limitation of our knowledge of the art permits, and while great improvements have been made in this matter the best filaments are still more fragile than are carbon filaments. The fragility has been the greatest obstacle encountered in the introduction of tungsten lamps, and in the beginning, when filaments were much more fragile than they are to-day, and when people had not learned the degree of care necessary in handling them, and when prices were very high, this weakness prevented many people from using the lamps. Now, filaments are much stronger, people have learned to handle the lamps carefully and prices are lower, so that the sales of tungsten lamps are increasing rapidly.

Flexible mountings for the interior structure of the lamps, which protect the filaments to a considerable degree, have been designed, and many lamps for railway car lighting and other special service are now being made, which have these flexible supports, to prevent breakage of the filaments in shipping and also in use.

The latest development which has been publicly announced is the drawn tungsten wire filament. This drawn wire has a tensile strength greater than steel and can be drawn to any desired size. These filaments are very strong and are not injured by rough handling. In life and efficiency they are fully equal to pressed filaments.

PROTECTING AND REGULATING LIGHTING SYSTEMS.

In a paper entitled "Some Developments in Modern Lighting Systems," Mr. C. W. Stone discussed certain features of protection and regulation as applied to lighting systems. The author remarked that it seems to be impossible to install the circuits, busbars, feeders, etc., so as to prevent short-circuits. With small systems a short circuit can readily be handled by existing switching apparatus, but as the systems increase in size, short-circuits become more serious, and with large modern steam turbines the destructive effect due to a short-circuit is almost unlimited. With the old reciprocating engine the short-circuit current might rise instantaneously to 15 or 20 times normal, while with the modern high-speed steam-turbine generator the short-circuit current would probably be at least 50 times normal, and in such a central station as that of the Commonwealth Edison Company, with all the apparatus operating in parallel, the total instantaneous power is probably as great, if not greater, than that of Niagara Falls. In consequence, it would seem advisable to operate such a system in sections; that is, only a certain number of units should be operated in parallel at one time. This method of operating, however, has its operating disadvantages and is not the most economical method.

It is proposed, therefore, to install a reactor in the circuit in each machine. By this means it is possible to keep the current incident to short-circuit within reasonable limits. If such a reactor is used with each machine and the buses are divided into sections—each section with not more than 50,000 kw—and there is placed in circuit between the sections a reactor of such reactance as to allow the transference in either direction of the full output of one unit, the short-circuit current can be kept down sufficiently low to make it possible to handle it successfully with modern switching devices, and the disturbance to the system will probably be kept down sufficiently so as to make it possible to keep synchronous apparatus in step.

As the individual units become larger it would seem advisable to design them for low potential, thus making it possible to use deep slots in the armature and a distributed winding, and thereby obtain a higher reactance, thus reducing the value of the external reactance which will have to be used. The design of the reactors is a serious problem. They must be built so as to withstand enormous strains; they must be thoroughly insulated from ground, and must be of the coneless type, as the introduction of any iron in the unit would limit its instanttaneous effect.

The 20,000-kw generating units recently purchased by one of the large operating companies are designed for low voltage, and the reactance, instead of being obtained in separate reactors, is provided for in the design of the step-up transformers. The transformers are designed for low saturation so as to make it possible to realize as much of the effect of the reactance as possible on instantaneous short-circuits. The total reactance of each of these units—that is, considering the turbine unit and its compensator as a unit—is about 8 per cent, and it is proposed to operate not more than three of these machines in parallel at one time on one section of the bus. Between the sections of the bus, reactors will be installed as above described.

Among the points being more generally recognized by central station operators, the author called particular attention to regulation. He stated that a careful study of the lamp renewals on a system would show in most cases that a considerable expense would be justified for improving the regulation simply on the score of lamp renewals. It is possible, by means of automatic regulation, to maintain better regulation on an alternating-current system than can be obtained on a direct-current system. In an alternating-current system the electromotive force of each feeder can be adjusted properly at all times by means of an automatic feeder regulator, and in case the substations are of the type using frequency-changer sets, generator regulators can be used in addition. If the same care is then utilized in the laying out of the feeder system as is usually employed in a direct-current system, the best results can be realized. The generator regulator is of a type which is practically instantaneous in its operation and in consequence responds very quickly to sudden changes in load.

There are now on the market several types of feeder regulators, most of which are good, and which will readily earn their cost in a very short time, but oftentimes these regulators are improperly installed; that is, three-phase regulators are used where single-phase regulators would be preferable. On circuits where the load is more or less rapidly changing, the switch type of regulator seems to be the best type to be used as it will always be quicker in its operation than those of the induction type. In the last few years the design of the induction type regulators has been changed and their speed has been greatly increased. However, the induction type of regulator has a variable torque. The torque varies with the load on the circuit and also varies with the position of the regulator. In order to get high speed it is usual to make use of a motor with a high-speed characteristic; that is, a motor which can reach its speed in the minimum of time. If a regulator of this type is designed for operation from one end of its range to the other, in, say, 10 seconds, it will in many cases be good enough for the service required, but, of course, it can never be as fast as the switch type of regulator as a large proportion of the time required will be consumed in getting started. With the switch type of regulator the moving parts are very light and consequently have small inertia and the torque is constant at any point of its range. It is possible, therefore, to use a small motor and magnetic clutches for transmitting the motion to the switch. With both types of regulators a potential relay is required and with the induction regulator a reversing switch is required. With the switch type of regulator the current used in the clutches can be handled directly by the potential relay. This in turn tends to cut down the time required for the operation. The complete range of the regulator can be made very much faster than that of the induction regulator and the speed of operation will be constant throughout the entire range, and it is probable that on circuits where the fluctuations on the load are very rapid it will have done its work before the induction regulator has started.

Pittsburgh Meeting of the American Electrochemical Society.

In last week's issue was printed the report of the seventeenth general meeting of the American Electrochemical Society at Pittsburgh, May 4 to 7, together with abstracts of several of the papers read. Below are given abstracts of other papers presented at the meeting, which were omitted last week owing to lack of space.

SCIENCE AND INDUSTRY.

At the evening meeting, May 5, Dr. Leo H. Baekeland presented his presidential address on "Science and Industry." He asserted emphatically that the two most powerful men of our generation are the scientist and the engineer, though this fact is not yet realized by society at large; and that "the last 100 years under the influence of the modern engineer and the scientist have done more for the betterment of the race than all the art, all the civilizing efforts, all the so-called literature of past ages for which some respectable people want us to have such an exaggerated reverence."

If our age is one of national industrialism, of applied science, how is that in some industries quality is going down, while prices are soaring upward? Dr. Baekeland emphasized the fact that just such commodities as are produced by so-called scientific industries are sold cheaper and are of better quality than ever before, and the cheapening of price or bettering of quality is almost proportional to the amount of scientific knowledge involved in their production. This condition was shown by examples from the electrical and the chemical industries.

Matters are not always so satisfactory where large corporations are concerned, where the directors know little else of the technical side of the business than that it pays dividends.

Resourceful as is the modern engineer or chemist, his power is often simply a tool in the hands of ignorant but cunning men. In Germany in large engineering or chemical enterprises the board of directors is made up mostly of scientifically trained men, engineers, chemists and physicists. However, it is also possible to err on the side of a too one-sided scientific organization.

The last part of Dr. Baekeland's address was a very forceful exposition of the importance of the research chemist and of the way in which a research department should be run properly.

CHEAP ENERGY.

Prof. F. Crabtree then discussed the possibilities of cheap energy in the Pittsburgh district, dealing especially with energy generated from blast-furnace and by-product coke-oven gases. The paper contained a great many interesting figures of the cost of energy under different conditions.

INDUCTION FURNACE PROGRESS.

A paper on induction furnace progress in recent years was presented by Mr. T. Rowlands. The simple induction furnace of the Kjellin-Colby design, which is intended merely for melting, is now running in competition with the crucible process for the manufacture of high-class steel. It is also used for nickel melting and brass melting. The "combination induction furnace" of Roechling and Rodenhauser is used for melting and refining steel. Very interesting diagrams were given showing the various chemical reactions taking place during the refining process.

SILVER-ARSENIC-COBALT-NICKEL ORES.

A paper by Mr. C. C. Cito described a new process for the treating of cobalt-nickel ores rich in silver and arsenic by combined melting and electrolytic operations. The process consists, first in smelting the ore, to which has been added a certain percentage of copper. This process yields an alloy which contains, besides copper, all the silver, nickel and cobalt, and nearly all the arsenic in the ore treated, and, secondly, a slag containing a very low percentage of silver, nickel and cobalt. The alloy is subsequently separated by electrolysis, while the slag is used as flux in the blast furnace to recover the balance of the metals.

PYROMETERS.

The last paper of the Thursday evening session was presented by Mr. C. E. Foster on "a new radiation pyrometer." Its practical advantages are chiefly based on the fact that no careful focussing is required so that it can be used with little precaution in metallurgical practice.

DRY CELLS.

A paper was presented by Mr. D. L. Ordway on the evolution and present status of the dry cell. The value of the short-circuit current is often used as a means of determining the quality of a dry cell, but that it is not reliable for this purpose was clearly shown by the results of tests proving that there is practically no relation between the short-circuit current and the service capacity. Energy output or service capacity should decide the quality of a dry cell.

Results of tests were first given for continuous discharges of dry cells through different resistances, and then of intermittent discharges, and special methods were described for arranging the intermittent discharge to test dry cells for their use in the two most important applications—telephone service and ignition service.

MERCURY-CATHODE CELL.

A very interesting paper by Mr. Jasper Whiting described his new mercury-cathode cell for the production of caustic soda and chlorine by electrolysis of brine solutions. The cell is now in commercial use in a paper mill in New England. It differs from the Castner-Kellner process essentially in the fact that there is no continuous removal of the sodium amalgam from the anode to the cathode (oxidizing) compartment, but that the mercury cathode is maintained in a quiescent state during the deposition of the sodium and is transferred to the oxidizing compartment at regular intervals. The paper was discussed at some length by Prof. Burgess, Dr. Baekeland and Dr. Richards.

SEPARATION OF OIL FROM CONDENSER WATER.

A paper by Prof. H. M. Goodwin and Mr. Ridsdale Ellis gave the results of an experimental investigation suggested by various patents for the separation of oil from condenser water by electrolysis, particularly when sodium carbonate is added to improve the conductivity and when the electrolysis is carried out with iron electrodes. The chief results are as follows:

The oil particles in the emulsions investigated varied in diameter from 0.0006 to 0.00006 cm. and were negatively charged as shown by their migration to the anode under the influence of a potential gradient. The addition of dilute solutions of sodium carbonate does not produce de-emulsification. Partial de-emulsification of oil (from 50 to 60 per cent) is produced by electrolysis between platinum electrodes. Complete de-emulsification results from using iron electrodes. The essential part of the process is the removal of the oil by the basic ferrous carbonate, precipitated at the anode, coming into contact with the oil particles as they migrate to the anode; mechanical agitation of the emulsion with this precipitate serves, however, equally well to remove the oil.

TIN.

Mr. W. O. Snelling presented a paper on an electrolytic method for the reduction of cassierite. The method was suggested by the fact that when cassierite and zinc are in contact in an hydrochloric acid solution, cassierite is reduced to metallic tin by direct cathodic reduction. In the method described use is made of a double-compartment cell, in which the cassierite is anode in the first compartment, and metallic tin is obtained by a simple plating process in the second compartment. The process has been used so far only on a laboratory scale.

CUPROUS CHLORIDE SOLUTIONS.

A paper on the conductivity and electrolysis of cuprous chloride solutions, by Dr. M. deKay Thompson and Mr. E. R. Hamilton, showed that the conductivity of cuprous chloride solutions can be made as high as that of the copper sulphate solutions ordinarily used in copper refining, by the addition of hydrochloric acid. At room temperature a current efficiency of 90 per cent of the theoretical can be obtained when the solutions are acidified. The presence of free acid is therefore beneficial in every respect. The paper is suggestive, since by using a cuprous chloride solution for copper refining it might be possible to get twice the amount of copper per amp-hour obtained with the usual cupric salt solution.

NITRIC ACID.

Dr. H. E. Patten and Dr. W. J. McCaughey presented a third paper on their continued researches on the electrolytic reduction of nitric acid. In this paper it is shown again that hydroxylamine may be reduced to ammonia at a copper cathode in the presence of copper sulphate, sulphuric acid, and hydrochloric acid. Nitrogen is liberated at both the anode and the cathode. The rate of this liberation has been studied quantitatively.

Nitrogen is evolved at the anode at a fairly constant rate, ammonia being left in solution; at the cathode, nitrogen is set free rapidly at first, and in such quantity as to suggest the possibility of the formation of hydrazine as an intermediate step, and its subsequent oxidation by hydroxylamine, thus producing free nitrogen. As electrolysis proceeds, the formation of nitrogen gas decreases.

The evolution of free nitrogen in quantity is also met in the electrolytic reduction of nitrate under the same conditions and suggests that the hydroxylamine formed in the reduction of nitrate may in that case, too, be reduced to a lower stage of oxidation, such as hydrazine.

CONDUCTIVITY OF SOILS.

A paper by Mr. R. O. E. Davis, dealt with the effect of moisture and of solutions upon the electric conductivity of soils. This effect is shown to be very important, because soil in the dry conditions offers a very high electrical resistance. The conductivity of moist soil increases almost directly as the percentage of moisture increases, the amount of increase de-

pending upon the type of soil. Sodium carbonate has an effect of greatly increasing the conductivity. Humus decreases the conductivity of a soil.

ALUMINUM-CALCIUM ALLOYS.

A paper by Mr. James M. Breckenridge dealt with electrochemical potentials and electric conductivity of aluminum-calcium alloys. The chief result is the proof that the different micrographical constituents are responsible for abrupt changes in potentials and conductivity.

ELECTRO ANALYSIS.

A paper by Dr. J. W. Turrentine described the construction of a simple rotating graphite anode, to supplant the more expensive platinum anode in electrochemical analysis and other electrochemical processes in which a rotating anode is used.

A paper by Prof. Francis C. Frary and Mr. Andrew P. Peterson gave an account of a comparison of various rapid electroanalytical methods.

The differences in the electrodeposition of platinum under different conditions were discussed in a paper by Dr. W. J. McCaughey and Dr. H. E. Patten, and in addition anode and cathode discharge potentials were observed so as to assist in the interpretation of the results.

LEAD PLATING.

In a paper by Prof. Frank C. Mathers the use of a perchlorate bath was recommended for the electrodeposition of lead. The bath should contain about 5 per cent of lead, from 2 to 5 per cent of free perchloric acid, and 0.05 per cent of peptone. A current density of from 2 to 3 amp per sq. dm. (from 18 to 27 amp per square foot may be used. The peptone is gradually used up, and after about four days a quantity equal to the original amount should be added. The free acid, which is very slowly neutralized by chemical solution of the lead, must be restored by the treatment of a suitable portion of the solution with the right amount of sulphuric acid. The bath gives excellent purification, the cathode being about 99.98 per cent pure. The deposit is smooth, coherent, and has a density of 11.36. As a plating bath, the lead perchlorate solution works exceptionally well on account of the absence of "trees" or loose crystals on the edges even when the deposits reach a thickness of an inch. The bath shows no deterioration with use and gives as good deposits after two months as at the beginning if the concentration, acidity and the required amount of peptone are maintained.

DIAPHRAGM CELL.

A paper of Messrs. H. K. Richardson and R. L. Patterson described laboratory experiments with the Townsend cell with respect to its behavior under various current densities. The difference in the construction of their cell from the commercial cell and the effect of these differences on the results were discussed by Mr. Hooker.

MATTE ELECTROLYSIS.

"A new method for the electrolytic winning and refining of metals" was the subject of a paper by Mr. Edwin M. Chance. He suggests the refining of matte in the fused state. As an example he treats a copper-iron matte with an electrolyte of fused sodium metasilicate. When the e.m.f. is controlled properly, it is stated that copper is deposited on the cathode, while iron remains in the electrolyte as silicate. The sulphur appears to volatilize at the anode.

PUBLIC MEETING.

A special feature of the convention was the open meeting held on Saturday afternoon in the Carnegie Music Hall, to which the general public had been invited and which was very well attended. Mr. Chas. F. Scott presided.

With the aid of a long series of lantern slides, Dr. Jos. W. Richards gave a sketch of the present status of the electrochemical industries in the world and predicted a great future for Pittsburgh as an electrochemical center on account of the introduction of the electric furnace for steel refining.

Mr. John H. Finney, secretary of the Southern Appalachian Conservation Commission, presented an address on the conservation and utilization of natural sources of energy, with reference to desirable legislation.

The session was concluded by a most interesting speech by Dr. John A. Brashear, the astronomer, giving many delightful reminiscences of his contact in years past with various eminent scientists and especially reminiscences of the early work of Dr. E. G. Acheson in Pittsburgh.

Discussion on Public Service Commissions at the Nebraska Convention.

Mr. E. C. Hurd, expert for the Nebraska Railroad Commission, gave a short talk before the Nebraska Electrical Association convention, at Lincoln, May 5, which was followed by a general discussion. Mr. Hurd defined the corporation as a creature of law created primarily for the purpose of co-operation. The publish service commissions which have been proposed are not by any means altogether for the discipline of corporations. If a consumer has been told some absurd story about the low cost for which a kw-hour can be produced and is complaining for lower rates, the commission takes the place of a court for deciding questions in controversy. As far as the actual operators and managers of companies are concerned, it sometimes happens that the owners are not willing to let the operators do what the latter are convinced should be done for the public. In such cases the rules of the commission would be a help to the operators. From the standpoint of the owners of the property, the requirements of a commission to make reports according to uniform standards would be valuable, because frequently the owners are not thoroughly posted as to what their properties are really doing in comparison with others. Regulation by commission also tends to protect the smaller owners of the property against the manipulation of the larger ones. The commission would also settle the fact regarding the comparative efficiency of municipal and corporate ownership. He said that he believed it to be the interest of the association to further the movement for a State public service commission.

President B. C. Adams then called upon Mr. J. R. Cravath, of Chicago, to give his ideas on public service commission regulation as gathered from central station men in other States. Mr. Cravath said that the States in which regulation of electric light and power companies is under public service commission are Massachusetts, New York, Wisconsin, Vermont, New Jersey, Maryland and South Carolina. Ohio is about to pass a law. The Massachusetts commission has now been in force for so many years that it has ceased to attract much attention. The New York commission being new has attracted attention perhaps out of proportion to its importance. If we are to really study the results of commission government in the long run, we should go to Massachusetts. In that State it had worked out very satisfactorily for the consumer and the investor. In Wisconsin the Public Service Commission is composed of a very fine class of men of unquestioned integrity, who have as assistants a corps of experts, some of whom are connected with the University of Wisconsin, and all of whom are of high standing. The Wisconsin commission had been going very thoroughly into the question of costs and investments, preparatory to establishing precedents. One important case recently decided was that of the Madison Gas & Electric Company. The commission considered this case at great length, inquired into the investments made by the company, the rates charged, the cost of production and the profits. The proceedings of this case occupy a small volume. The commission fixed upon 8 per cent as a fair return upon the investment in the electric part of the plant. A reduction in rates was ordered, the system of rates being such as to correspond to the cost of production. In the case of the Ripon central station, a change of rates was recently ordered, which change would not effect the gross revenue of the company very much, but would distribute the cost of service more equitably among consumers. A two-rate system of charging was ordered, a certain primary rate being charged for a certain number of hours use per month of the connected load,

and a lower secondary rate for all kw-hours consumed in excess of that amount.

President B. C. Adams said that he resided in Wisconsin at the time the public service commission was first advocated by the followers of La Follette, and central-station men in the State had then been generally opposed to the idea. Now it is notable that the commission is being criticised for being too favorable to the companies. He thought that the tendency of commission control would be to limit to a certain extent the rate of growth of public service companies. He meant by this that the commission might not be willing to authorize as great an expense in a new business department as companies are now maintaining. The new business department in the Lincoln company has by the building up of profitable business brought about a reduction in the cost of gas and electricity.

Mr. Adams said that he had asked one of the Aldermen in Lincoln who had been violently in favor of municipal ownership of the gas and electric companies whether the municipality would maintain a new business department in the event of municipal operation. The Alderman said that it certainly would not. The conclusion is obvious. The municipality would not build up the business rapidly and therefore the cost to the producer could not be reduced as rapidly as under private control with an active new business department. Mr. Cravath said that the Wisconsin commission had recognized expense in promoting new business as a legitimate part of central-station investment or capitalization. In the Madison case, however, this was set aside for the reason that the commission decided that the company had been earning more than a reasonable return on its investment.

Mr. E. A. Bullock, of Norfolk, told of listening to the address of Hon. J. U. Sammis before the Iowa convention. Mr. Sammis is a member of the Iowa State Senate. Mr. Sammis made the point that commission regulation would put an end to the exploiting of public service companies by local politicians, as Mr. Bullock put it "at so much per exploit." Mr. Sammis had convinced him that he would like to operate under such a commission. As regards the competition between central-station systems in the same town, he thought competition from another company worse than the competition of a municipal plant. He asked the managers of the Lincoln Traction Company and the Lincoln Gas & Electric Company, who were present, whether they would not prefer to have the competition of a municipal plant rather than the competition they now have between themselves. The municipal plant manager would not hustle for business. No public utility should be competitive. Mr. Adams said that the Lincoln Traction Company had offered to furnish electricity at less than the present public cost of production. The city's only answer was "as long as the company will do this by all means let us maintain our municipal plant."

Massachusetts Commission News.

The Massachusetts Railroad Commission has issued a decision in favor of the Haverhill & Amesbury Street Railway in connection with the petition of the Selectmen of Salisbury relative to the maintenance and operation of the road between Salisbury Beach and Black Rocks. The board points out that the area formerly occupied by the tracks is partly under water; that the Merrimac River, on whose shores the track was laid, is a tidal stream, and that any reconstruction of the tracks upon their former location would probably be futile. The only effective method of obviating the difficulty would be the erection of a breakwater, at large expense. The board considers this not feasible, and, therefore, declines to make any recommendation to the company. It is probable that another location may be secured on private land, under the jurisdiction of the local authorities.

The Massachusetts Railroad Commission has issued an order sustaining the petition of the Northampton Street Railway Company for authority to raise fares between Northampton, Easthampton and Williamsburg, in accordance with a schedule filed with the Board and discussed at length in a recent public hearing. The Commission points out that the company's plan contemplates an increase of fare between Northampton and Williamsburg and between Northampton and Easthampton, leaving the fare within the city limits of Northampton at 5 cents as heretofore. After a careful study of the schedule and the company's financial condition, the Board finds that its consent should be given to the changes desired. The Connecticut Valley Street Railway Company has petitioned the Board for authority to carry freight and baggage in Hadley. The selectmen of Reading have requested the Commission to give a hearing upon the fares charged within that town by the Boston & Northern Street Railway Company. The Board has issued an order approving the issuance of additional capital stock by the Dartmouth & Westport Street Railway Company to the amount of 2375 shares, amounting at par value to $237,500. The Board approves the price of these shares at $150 each, as determined by the stockholders. The proceeds of 600 shares are to be used for the payment of funded indebtedness, and the rest to paying the cost of additions and improvements in the petitioner's property.

Massachusetts Legislative News.

The committee on metropolitan affiairs has reported to the House a resolution for an investigation by the Railroad, Harbor & Land, Boston Transit and Metropolitan Park Commissions, sitting jointly, of the advisability of the construction of a tunnel between the North and South stations at Boston. The board will probably hold hearings if the resolution passes as expected on the general problem, with special reference to the terms of ownership. At present the steam railroads which would build the tunnel are not in favor of a lease or temporary rights of any kind. Electricity will undoubtedly be the motive power for the tunnel service, and at least a partial terminal electrification of railroads would accompany the use of the tunnel. It is considered that economies in train operation would result from the use of an inter-station tunnel, since many suburban trains electrically propelled would be run from outlying districts on either side of Boston to the other. The transportation interests feel that the inter-station tunnel plan presents a different question as to ownership than do subways or tunnels built for operation by the local rapid transit system. In the latter case the underground tubes have been leased by the city of Boston for a term of years to the Boston Elevated Railway Company, and the rental includes a sinking fund sufficient to retire the bonds at maturity. There is more prospect of competition for the use of urban rapid transit tunnels than for the possession of operating rights in an inter-station tunnel, which would be of service mainly to the trunk lines, including their suburban trains. The committee on street railways has reported a bill providing for the transportation of pupils of industrial schools at half fare by electric roads, but this privilege does not extend to pupils of normal schools and business colleges. The committee has held several executive sessions on the bill to permit the Boston Elevated Railway Company to hold the stock of other companies. Counsel for the road have been present on invitation of the committee, and the questions of constitutionality and the safeguarding of the city of Boston in its tunnel and subway leases have been discussed in the presence of representatives of the Public Franchise League of Boston and the municipal law department.

The committee on taxation has reported a bill providing that so much of the corporate tax of telephone companies as corresponds to the proportion of stock owned by persons residing in the State shall be apportioned among the several cities and towns in proportion to the number of telephones operated in each municipality. By a vote of 117 to 74 the House has refused to adopt the order of Representative Hays of Boston for an investigation by a recess committee upon the making of false statements in regard to sales of stocks and bonds. The committee on metropolitan affairs has reported against the bill prohibiting the further construction of elevated railways in

Boston. The same committee has voted to submit a resolution to the House providing for an investigation by the Massachusetts Railroad Commission of the electrification of railroads within a 10-miles radius of Boston, and a report by the Board by Nov. 1 of this year. The committee recognizes that although electrification has been considered to some extent every year for the past decade, the pressure of public sentiment in favor of definite steps toward its consummation has been stronger during the present session than ever before. In connection with the general subject of electrification at Boston the recent bill signed by Governor Draper permitting railroads to use such other power than steam or electricity, alone or in combination, as the Railroad Commission may approve, is of interest. This legislation was procured by the Boston, Revere Beach & Lynn Railroad, a narrow gauge line serving a portion of the North Shore suburban district, to enable the company to experiment with gasoline and gasoline-electric cars. The company is investigating these motive powers on the ground that external electrification is inadvisable for it under present conditions. The traffic of the line is dense, distances are short and grades light. The present service is excellent except in point of speed, and sooner or later it is probable that electrical operation in some form will be required.

The committee on metropolitan affairs has requested the Railroad and Boston Transit Commissions to frame a bill giving the Boston & Eastern Electric Railroad Company the right to build a tunnel under Boston Harbor for the purpose of entering the city in connection with its proposed high-speed electric line to the northern suburban district. This action means that after nearly four years of struggle the company makes a sure step toward the consummation of its plans, which have been vigorously opposed by all the existing transportation agencies from their inception. The Railroad Commissioners have already declared that the road is a necessity, although a formal certificate of exigency has been withheld on account of the absence of legislation permitting the company to build a tunnel and subway in connection with the Boston end of its route. The committee asks the two commissions to fix the location of the tunnel and its terminals, suggests that the company shall be required to furnish evidence of its good faith in the form of a deposit, and that the bill shall require the work to be completed during a specified period. The tunnel is not to be allowed to interfere with a possible tunnel between the North and South Stations, and the rights of the public and the city of Boston are to be specially looked after in the act. It is anticipated that there will be a battle royal over the bill when it enters the Legislature. The House has substituted a bill by Representative Conway for an adverse report of the committee on street railways upon the regulation of the hours of labor of employees as set forth in bills before the committee. The Conway bill now before the House provides that a day's work for all conductors, guards, drivers and motormen who are employed by any street or elevated railway company shall not exceed nine hours, and shall be so arranged that it shall be performed within 11 consecutive hours. On legal holidays, Sundays and in case of accident or unavoidable delay extra labor may be performed for extra compensation.

The Senate has rejected the bill providing for the transportation of normal school pupils on street and elevated railways at half fare after a sharp fight on its behalf by its supporters. Senator Bennett condemned the bill on the ground of its unconstitutionality. The title is a misnomer, since the Legislature cannot interfere with the fares of the Boston Elevated Railway Company by the terms of the elevated charter. He contended that if the Boston Elevated is to be left out the bill would be unfair to the other companies in the State. Children of the public schools now ride at half fare, but that is because the Supreme Court has ruled that they are wards of the State. The attorney-general has ruled that pupils of normal schools clearly do not come within the scope of the half-fare act. It is probable that an attempt will be made to reconsider the bill. The bill providing for a relocation of the westerly terminal of the Riverbank subway has been ordered to a third reading in the Senate, and the same body has passed to be engrossed the bill extending the authority of the Railroad Commissioners over street railway bond issues. The resolution providing for the investigation by the Boston Transit of the cost and feasibility of subways to Dorchester, Milton and South Boston has been passed by the House. The bill providing for the sale of electricity by the Metropolitan Water & Sewerage Board within the town of Clinton has been laid before the governor, and the same action has been taken on the bill permitting temporary locations for street railway companies by approval of the Railroad Commission. Representative Cushing has introduced a resolution for the committee on metropolitan affairs providing for an investigation of the advisability of constructing a tunnel between the north and south stations. The bill authorizing the Shelburne Falls & Colraine Street Railway Company to fund its indebtedness has been laid before the governor.

Oklahoma Corporation Commission.

Some weeks ago the electric light and public service companies of Oklahoma received courteous requests for copies of their rate schedules from the State Corporation Commission at Guthrie. Some companies readily acquired, though others did so under protest, having the acumen to perceive that thus submitting these rate schedules in accordance with the apparently innocent request, was virtually placing them on file and record with the State authorities who occupy a singularly powerful and final position in Oklahoma.

Following this incident, on May 5, the Corporation Commission promulgated the order that "all transportation, transmission, electric light, heat and power companies doing business within the State of Oklahoma, shall in their financial dealings with the public charge and collect and receive only the amounts of their published rates or such rates as are on file with the Corporation Commission, and in the collection of such rates they shall give and make exact changes with their patrons and customers."

The electric companies naturally feel, that, as in nearly all cases their franchises originate with their own citizens, and in many instances were granted before the creation of the new State Government or the Corporation Commission, it is without the function of the commission to fix or enforce these rates which refer to the local bodies alone. The new order prevents any amendment of rates without a hearing before the commission at Guthrie.

The second part of the order relating to the making of exact change for customers' bills, refers to the local tendency, generally prevalent in all transactions throughout the West, to disregard any amount less than 5 cents. Heretofore many companies have been collecting the odd cents, when the bill remainder read for more than half a nickel (as, say, 68 cents, in which case 70 cents would be collected), giving the customer the odd cents when the remaining amount was less than half a nickel. Although this arrangement resulted in about an even break for both customer and company, and is the general western practice in all merchandising transactions, the Oklahoma commission insists that exact change be made.

Public Utility Control in Chicago.

At the meeting of the City Council, of Chicago, on May 9, Alderman Foreman introduced an ordinance to create a Department of Public Utilities, to be in charge of a commissioner, with bureaus for local transportation, electric light and power, gas, telephones and industrial railroads. In offering the ordinance, its sponsor announced that it was not his intention to urge its immediate passage, but that he would favor public hearings in committee upon various aspects of the proposition in advance of decisive action by the Council. The proposed ordinance was referred to the committee on judiciary.

Illinois has no public-service commission, although a bill providing for one was introduced at a recent session of the Legislature. It is asserted that there is a strong feeling in

Chicago against State control of local public utilities, and the proposed municipal department is suggested as a means to obtain more effective regulation of public-service utilities under local control. Possibly the public-service corporations themselves would prefer State control to municipal control, but at any rate ample opportunity will be given, no doubt, for discussion of the proposed ordinance before it is passed.

New York Public Service Commission News.

At its regular meeting last week the Public Service Commission of the First District of New York adopted a resolution instructing the chief engineer of the commission to prepare a report as to the feasibility, from an engineering point of view, of constructing a rapid transit subway from the Battery via Greenwich Street, West Broadway, Varick Street, Seventh Avenue, Fifty-ninth Street and the Queensboro Bridge to Jackson Avenue in Queens Borough. It is proposed to continue the lines on elevated structures through Queens Borough, the exact routes to be determined later. The West Side line has already been authorized by the old rapid transit commission as a part of the present subway system, leaving the route optional between Seventh and Eighth Avenues. It was supposed that the Interborough Company would make a proposition to construct the line, but none that the commission is willing to accept has ever been offered. A hearing on the route was ordered for May 26.

Governor Hughes has signed the debt limit bill which will carry into effect the constitutional amendment adopted last fall eliminating from consideration in the calculation of the city's debt all self-supporting bonds. The Court of Appeals will be asked at once to designate what bonds are so eliminated and the city will have its borrowing power increased something like $100,000,000. Everything is now ready for the advertisement for bids on the Broadway-Lexington Avenue route as soon as the forms of contract are finally settled.

The question of pipe galleries in the new subways has not yet been determined by the Board of Estimate. It is feared that their inclusion will delay letting the contracts for the subways.

The hearings as to the rates for gas and electric energy charged by the Queens Borough Gas & Electric Company, have been postponed until June 23. These hearings were ordered upon complant of consumers. At the suggestion of the commission the consumers and the officials of the company had several conferences in an effort to agree upon rates, but without success. The matter has now been returned to the commission for adjustment.

The Public Service Commission, Second District, has received a petition from the Economic Power & Construction Company and Geneva-Seneca Electric Company for consent of the commission to the transfer of the franchises, works and system of the Economic Power & Construction Company in the city of Geneva to the Geneva-Seneca Electric Company. There is now pending before the commission a complaint on the part of the Geneva-Seneca Electric Company that the Economic Power & Construction Company is unlawfully exercising franchises in the city of Geneva.

The Economic company commenced doing business and believed it had a right to act under its act of incorporation and perform the services of an electric company in the city of Geneva without the consent of the municipal authorities or the commission, until the Court of Appeals last year decided that it did not possess such right. It then secured a franchise from the city of Geneva and applied to the commission for permission to exercise its franchise. The application was opposed by the Geneva-Seneca Electric Company, which is engaged in furnishing electric energy in that city. It is stated that negotiations have resulted in an agreement for the Economic Power & Construction Company to dispose of its property to the Geneva-Seneca Electric Company in view of the fact that the city of Geneva has not sufficient population to justify the existence of two such plants in that city. The application states that the proposed arrangement for combination of the properties will result in a saving of operating expenses of $20,000 a year in the operation of the combined properties, including the steam heating plant. It is proposed to pay the Economic company $103,000 for its property, works, plant and franchises. Sufficient bonds to effect the purchase are also asked to be authorized.

Double Catenary Construction for Tunnels.

A method of supporting double-messenger catenary trolley systems for use in tunnels, under bridges and in other places where the overhead space is limited, is the subject of a patent recently issued to Messrs. H. P. Davis and Theodore Varney. This construction provides a means of insulating the trolley conductor from ts supporting messenger cables, which are in turn insulated at their points of suspension. The practice has previously been to treat both the messengers and trolley as electrified conductors, but the necessary close proximity of the charged messenger to the grounded roofs of tunnels and covered structures makes this construction unsatisfactory in those places.

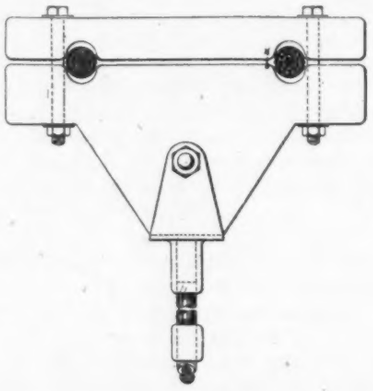


Fig. 1—Support for Contact Wire.

For continuing double-catenary trolley through tunnels and under bridges the trolley conductor is carried in the clamp shown in Fig. 1, which is in turn seated in the roughly triangular treated wooden clamping block which grasps the catenary messengers. The short pipe section between the clamping block and trolley car provides an adjustable link which permits allowance to be made for the catenary curve of the messenger.

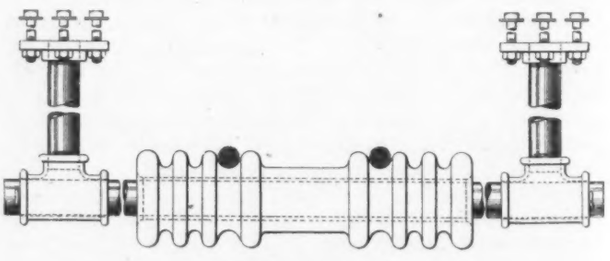


Fig. 2—Support for Messenger Cables.

The messenger cables are in turn supported and insulated by the structures shown in Fig. 2, comprising suspension pipes and a cross-piece carrying the fluted insulating collar, which seats the suspension cables firmly in position. It will be noted that the cross-piece is not threaded into, but passes through the T-fittings, being held in place by cotter pins. This construction enables the cross-pipe to be put up or taken down after the supports have been installed, in case repairs become necessary.

CURRENT NEWS AND NOTES.

Meter Tests.—Of 7,969 tests of electric meters made by the New York Public Service Commission, Second District, in March, 1910, 5736, or 71.98 per cent, were accurate; 739, or 9.27 per cent, were fast, and 1494, or 18.75 per cent, were slow.

Control of Telephone and Telegraph Companies.—The New York Assembly Rules Committee has favorably reported the Merritt bill placing telephone and telegraph companies under the jurisdiction of the Public Service Commission, Second District.

New Steel Plant at Gary.—It is reported that the National Tube Company, which now owns plants at McKeesport, Pa., and Lorain, Ohio, will begin the construction of a large plant at Gary, Ind., within a few weeks. The plant will give employment to from 15,000 to 18,000 men.

Spring Meeting of the A. S. M. E.—The American Society of Mechanical Engineers will hold its spring meeting in Atlantic City, N. J., on May 31, June 1, 2 and 3. Among the papers to be presented are three dealing with gas-engine plants. Prof. A. J. Frith will read a paper entitled "A Regenerator Cycle for Gas Engines Using Subadiabatic Expansion." A paper on "Gas Engines for Driving Alternating-current Generators" will be read by Mr. H. G. Reist. Mr. H. J. Freyn will relate "Some Operating Experiences With a Blast-Furnace Gas Power Plant."

Wireless Connection with Timbuctoo.—The wireless stations on the Eiffel Tower and the Paris Observatory, Paris, are now in communication with stations on the coast of Tunis and Algeria, and it is said that additional posts are in process of construction at Konakry in French Guinea, Monrovia in Liberia and even in Timbuctoo in the Soudan. It is also asserted that the French Government is planning wireless stations in the French Congo, one to be in the neighborhood of Lake Tchad. It is reported that communication is now successfully maintained over a distance of 2000 miles.

New York Section, I. E. S.—At a meeting of the New York Section of the Illuminating Engineering Society to be held on June 10, Dr. E. B. Rosa, of the United States Bureau of Standards, will read a paper dealing with photometric standards, while a paper devoted to incandescent electric lamps as standards will be presented by Messrs. C. H. Sharp and P. S. Millar, of the Electrical Testing Laboratories. At this meeting section officers for the next year will be elected. The nominating committee has suggested the following men for the offices indicated: Dr. A. H. Elliott, chairman; Mr. A. J. Marshall, secretary; Messrs L. R. Hopton and S. G. Rhodes, managers.

Indiana and Michigan Independent Telephone Convention.—Nearly 500 persons attended the joint convention of the Independent Telephone Associations of Indiana and Michigan at South Bend, Ind., on May 11 and 12. Among the papers read were: "The Necessity for Closer Corporate Union of Independent Companies," by Mr. J. A. Russel; "Insurance," by Mr. J. B. Hogan; "Telephone Accounting," by Mr. J. W. Coffey; "Depreciation," by Mr. E. L. Cline; "Long-Distance Operating and Advertising," by Mr. W. S. Vivian, and the "Necessity of a Toll-Line Clearing House," by Mr. N. G. Hunter. The Indiana association selected the following officers: President, Mr. N. G. Hunter, Wabash; secretary-treasurer, Mr. Walter J. Uhl, of Logansport.

Wireless Time Signals for Mariners.—According to press dispatches from Paris the French Government, beginning May 23, will announce by wireless transmission the exact time for the benefit of mariners as determined by the pendulum at the Paris Observatory. Messages will be sent at midnight and at two minutes and four minutes after midnight. This service is intended to supplement, or possibly supersede in some cases, the use of highly accurate chronometers. In addition, another pendulum in the Eiffel Tower will be used, by means of a wireless apparatus, to transmit a Hertzian-wave impulse every second, by which the longitude in distant places may be determined. Professor Claude and Professor Drinacort will have charge of this service, it is said.

Mono-Rail Road for Alaska.—According to reports attributed to Mr. Louis Brennan, he has granted a license to Major John E. Bellaine, one of the original promoters of the Alaska Central Railroad, for the extension of that railway on the Brennan mono-rail system for a distance of about 100 miles. The object of the extension is to connect the line with rich coal fields situated about 185 miles north of Seward, which are said to contain seams of bituminous and anthracite coal up to 38 ft. in thickness. It is possible that the 100 miles may be increased to 1000 miles, but in the meantime Major Bellaine has undertaken to finish the present extension by December, 1912. He estimates that the cost of rails will be $1,870 a mile, sleepers $280, labor, equipment and other expenses $2,750, or about $5,000 a mile. He proposes to start working with two cars, each capable of carrying 50 or 60 passengers and of making two journeys a day at 20 miles an hour. He estimates the receipts will amount to a total of $200,000 a year.

District Steam Heating.—The District Steam Heating Association will hold its second annual convention at Toledo, Ohio, on June 1, 2 and 3. Among the papers to be presented are: "Descriptions of a Modern Central Hot-Water Heating Station," by Mr. W. A. Wolls; "Central-Station Heating in Detroit," by Mr. A. D. Spencer; "The Necessity and Benefits of Humidity," by Mr. W. W. Brand; "Central-Station Heating," by Mr. F. H. Stevens; "A Study on Insulation," by Mr. A. C. Rogers; "A Study in Centralizing the Heat Supply," by Prof. J. D. Hoffman; "Advantages to be Derived from the Combination of Heating and Power Business for the Central Station," by Mr. R. De Wolf; "The Profitable Operation of a Central Station Without the Assistance of Electrical or Other Industries," by Mr. Byron T. Gifford; "The Factors that Enter Into the Cost of Generating and Distributing Steam for Heating," by Mr. Charles R. Bishop; "The Relative Efficiency and Resistance to Corrosion of Different Types of Radiators," by Mr. Herbert Orr; "Coal Production and Consumption," by Prof. R. H. Fernald. The president of the association is Mr. A. C. Rogers, Toledo, Ohio.

Electric Railways.—In a paper read before the Central Club, at Buffalo, on May 13, Mr. Frederick Darlington stated that estimates recently prepared for the electrification of about 100 miles of single-track railroad, with about 25 miles of side tracks and with heavy grades to be climbed and very heavy and frequent trains to be handled, show the total cost of direct-current transmission and distribution apparatus, including substations, to be $2,381,000, and for single-phase alternating current with transformer stations $1,011,000. This was figured for 1500 volts on a third rail for direct current and 11,000 volts on an overhead trolley for single-phase current. The difference in cost of the two distribution systems is $1,370,000. However, the single-phase locomotives for the same railroad would be more costly than direct-current locomotives by about $374,500, but this amount is only about one-quarter of the difference in the cost of the transmission and distribution appliances. In discussing the paper Mr. L. R. Pomeroy said that the advocates of electric traction have been dwelling on only a small portion of the various elements involved in the cost of transportation and that the effectiveness of engineering recommendations is somewhat diminished by the fact that the advice given is not always disinterested. He remarked that the electrical achievements thus far made, while mainly confined to passenger traffic, have shed little light, except in special cases, on the larger problem of freight train operation.

Illinois Electric Light and Power Bulletin.—Secretary H. E. Chubbuck of the Illinois State Electric Association, Mayer Building, Peoria, Ill., has issued, for the members of the association, an electric light and power bulletin giving rates for electric light and power charged by 20 central-station companies, ranging from towns of 1200 population to 75,000.

New York Electrical Society.—The nominating committee of the New York Electrical Society has suggested the following men as officers for the 1910-11 year: Mr. Robert T. Lozier, president; Messrs. H. L. Doherty, A. M. Huntington and E. Woltmann, vice-presidents; Mr. G. H. Guy, secretary, and Mr. H. A. Sinclair, treasurer.

Oklahoma Convention in September.—The meeting of the Oklahoma Public Utilities Association held at Sapulpa, Okla., May 10, was adjourned, on account of the small number of plant operators present, to convene again at Oklahoma City, Friday and Saturday, Sept. 30 and Oct. 1, 1910. Mr. Galen Crow, of Guthrie, Okla., is secretary of the association.

International Railway Fuel Association.—The second annual meeting of the International Railway Fuel Association will be held at the Hotel La Salle, Chicago, on May 23-26, inclusive. This organization is composed of steam railroad men, and various questions relating to grades of fuel for locomotives, systems of accounting for fuel costs, methods of purchasing coal and the like will be discussed. Mr. Eugene McAuliffe of the Frisco Lines, Chicago, is president of the association, and Mr. D. B. Sebastian of the Rock Island Railway, 327 La Salle Street Station, Chicago, is secretary.

Telephone Company Announces King Edward's Death.—Every person who called up any exchange of the Chicago Telephone Company on May 6 between 6 p. m. and 10 p. m. was given this message without solicitation by the operator: "King Edward died at 11:45 p. m." The difference in time between London and Chicago accounts, of course, for the difference in the hours named. So many inquiries were received earlier in the day in relation to the dying king that a general order to operators to make the announcement was issued as soon as the king's death become known. In this way the news was carried to thousands of persons.

Electric Club of Chicago.—Mr. John P. McGoorty, of the Chicago bar, and for eight years a member of the Illinois House of Representatives, where he was conspicuous on the side of good government, was the speaker at the weekly luncheon of the Electric Club of Chicago on May 11. His subject was "Good Citizenship," and he pointed out that while all American citizens have patriotic impulses comparatively few take sufficient interest in public questions. The negatively good man was criticized. If there are bad conditions, the fault lies with the individual voters. The character of prospective legislators should be scrutinized. In benefiting public conditions the homes and general business of the country are also benefited. At the close of Mr. McGoorty's address, which was appreciated, it was announced that a question box would be a feature of future meetings of the club.

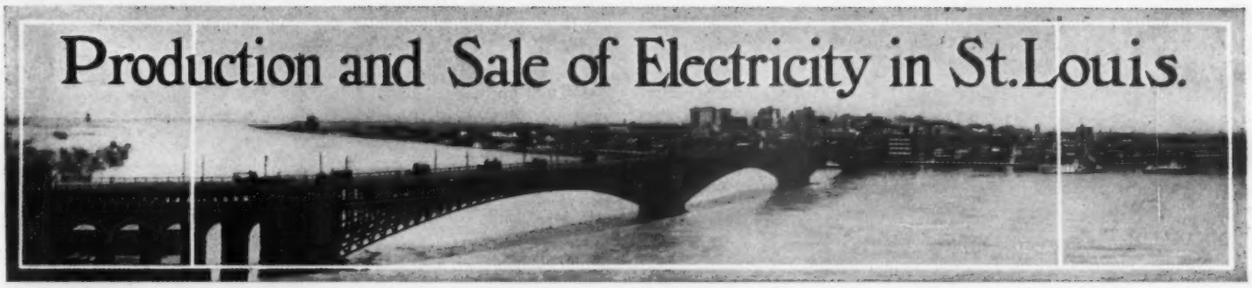
Special Chicago Train to St. Louis Convention.—Arrangements have been made by Mr. John J. Schayer, assistant master of transportation of the National Electric Light Association, by which a special train over the Chicago & Alton Railroad has been provided for delegates and visitors from Chicago and vicinity to the St. Louis convention of the N. E. L. A. This train will leave the Union Station, Chicago, Monday, May 23, at 10:00 a. m., reaching St. Louis at 4:30 p. m. It will consist of club, parlor, dining and observation cars, and will be a handsome train. The Central Passenger Association has granted an open rate of a fare and a half for the round trip, good going May 21, 22 and 23, and returning until May 30. Applications for reservations on this train should be sent to Mr. Schayer at 657 Railway Exchange Building, Chicago, as soon as possible.

Denver N. E. L. A. Meeting.—The Denver branch of the National Electric Light Association held an informal dinner the evening of April 23. The toastmaster was Mr. George W. Bixler. Mr. John T. Brady gave the history and progress of the N. E. L. A. Mr. C. N. Stannard, secretary of the Denver Gas & Electric Company, gave an address on "The Relation of the Engineer to the Commercial Man," in which he made a plea for all-around education, so that they may be both engineers and commercial men. He said that is what the big corporations are demanding, and that men who have grasped both the technical and the business side are the coming men. Rev. Thomas H. Malone, defending corporations, told of the part they have played in the great industrial systems of the country, and said that it is madness to think that 100 little concerns with 100 little heads will ever be substituted for any of our great corporations. "Our present economic system can no more be swept aside than can the incoming tide of the ocean be stopped with a broken broom."

Light Pressure.—An interesting lecture was recently delivered before the University of Paris by Professor Poynting of the University of Birmingham. Experiments were made showing the existence of momentum of radiation and methods of making quantitative measurements of the values explained. The experimental work and especially the quantitative measurements require the highest degree of skill, because of the very small magnitude of the forces. On the earth and in the atmosphere these phenomena are too minute to be detected, but in the interplanetary space, where a perfect vacuum exists, these forces become very large; for instance, it is calculated that the sunlight exerts a force of 70,000 tons upon the earth. This at first seems very large until it is recalled that the gravitation force between the sun and earth is 40 million million times greater. The author pointed out that the forces exerted on the planets by the pressure of impinging radiation must have a very considerable effect, when acting through ages of time. The pressure exerted by radiation from the sun upon a body acts against gravity, and as the size of the body is reduced the ratio of radiation pressure to gravitation increases until a point is reached where the radiation pressure exceeds gravitation when the body is driven out of the solar system entirely.

Resistance Thermometers Imbedded in Concrete of Gatun Locks.—Six resistance thermometers will be imbedded in the walls of the locks at Gatun, Panama Canal, in order to determine the degree of heat attained at various stages of the hardening of the concrete. By this means data will be obtained in relation to the heat produced by the chemical changes coincident with the hardening of the concrete. The thermometer consists of three parts—a resistance bulb, wires connecting the bulb with an indicating instrument and the indicating instrument itself. The resistance bulb is an iron cup in which is inserted a coil of wire by means of which the temperature is determined. This bulb is imbedded in the concrete at any point desired, and two lead-sheathed copper wires connect it with the indicating instrument. The resistance of the circuit is determined at the time of installation and the corrections remain practically constant. Any number of bulbs may be connected with a single indicating instrument, but at Gatun provision is made for eight bulbs. The indicating instrument and the switches connected with it are mounted on a marble slab, the set being a portable one. By closing the circuit of any thermometer by a push-button switch, the resistance is measured and the instrument records it in terms of temperature. A small storage battery furnishes the electrical energy. The readings from these thermometers will be plotted, and in this way a complete graphical record of the varying temperature of the concrete will be kept.

Production and Sale of Electricity in St. Louis.



HISTORICAL.

Pioneer Work in Electric Lighting and in the Development of Central-Station Organizations.

ELECTRIC lighting in St. Louis dates back to 1878, when a Gramme alternating-current arc-light machine, imported from Paris by Mr. Carl Heisler, was set up in a restaurant at Broadway and Elm Street. The outfit consisted of a revolving-field alternator, excited by a direct-current generator, and supplied energy to 12 Jablochkoff "candles" connected in four sets of three each. In the same year, a Hochausen arc outfit was received in St. Louis, and was used to supply electricity to a street lamp, and later to furnish light in the city library. Use was made of a foreign arc lamp, imported by Mr. Adolph Busch, which failed to maintain continuously the automatic adjustments for which it had been designed. In order to overcome the irregularities in the operation of the feeding mechanism, a small boy was employed to pull a string for separating the carbon electrodes when they failed to be drawn apart by the mechanism. These early attempts were rather of the nature of exploitations of curiosities, and although the operation of the apparatus was unsatisfactory, the novelty of "electric light" attracted interested crowds.

St. Louis, however, continued for some years its pioneer work in electric lighting, during which period it also played a leading part in the commercial development on a large scale of electric traction. It can boast of having been the seat of the first commercial development of the series incandescent street-lighting system—the Heisler; the first city to have a central station for power service alone; of having at one time the largest arc-light plant in the world, and at another the largest alternating-current station in the world.

In 1882 the Brush Electric Association was established to operate a Brush multiple-series system of commercial lighting, using incandescent lamps in series with arc lamps. As the accompanying genealogical sketch shows, this company may be taken to be the first ancestor of the present Union Electric Light & Power Company. During the following four-year period, there were also started the St. Louis Thomson-Houston Company, the St. Louis Illuminating Company, the Heisler Electric Company, the Excelsior Electric Company and the Western Electric Company. The interest of four of the preceding companies were, in 1888, gathered together in the United Electric Light & Power Company, which in 1889 was combined with the St. Louis Illuminating Company. Meanwhile the Municipal Electric Light & Power Company had entered the field with a 500-volt, direct-current system and an alternating-current system involving the first local use of transformers. In 1890 this company was reorganized, taking over both the Heisler and St. Louis Illuminating Companies. In 1895 its name was changed to the Edison Illuminating Company of St. Louis, which combined in 1897 with the alternating-current system of the Missouri Electric Light & Power Company, and the 200-volt, direct-current system of the St. Louis Electric Light & Power Company, to form the Missouri-Edison Company.

The Citizens' Electric Light & Power Company, which was organized back in 1891, and the Imperial Electric Light, Heat & Power Company, formed in 1896, were combined in 1902 to form the first company of the name of the Union Electric Light & Power Company. In 1903 this company combined with the Missouri-Edison Electric Company, before mentioned, forming the present Union Electric Light & Power Company. In 1904 the latter acquired control of the Carondelet Electric Light & Power Company (which had been in service since 1891), and in 1907 purchased the Laclede Power Company. The Seckner Contracting Company, which the Union Company controls, holds the contract for the city street lighting until September,

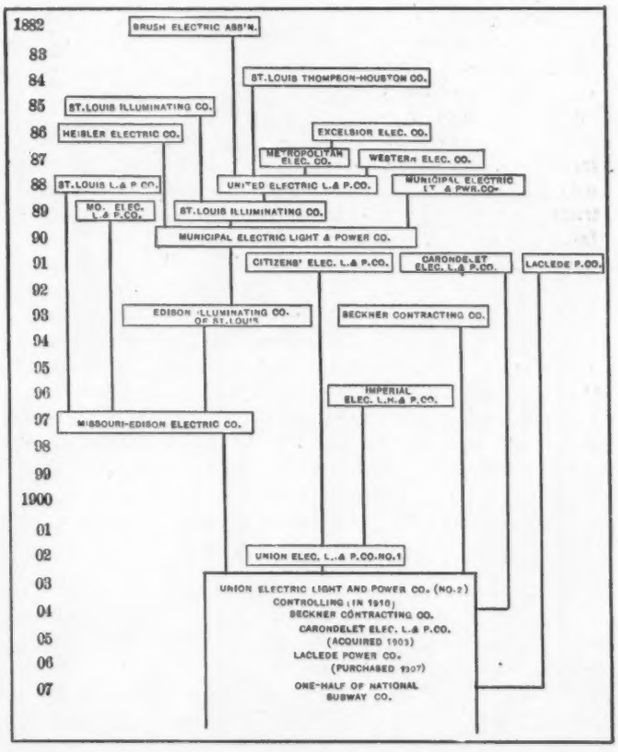


Fig. 1—Genealogical Sketch of Union Electric Light & Power Co.

1910, when it will probably pass out of legal existence, the Union Electric Light & Power Company having secured the contract for the next 10 years. The Union Company also has a half interest in the National Subway Company, which owns an extensive system of underground conduits in the downtown district.

The Laclede Gas Light Company, which went into the electric-light business in 1890, supplies its customers in the Keyes

underground district under the name of the Phœnix Heat, Light & Power Company. Since the destruction by fire of its own generation station in January, 1907, the Laclede Gas Light Company has purchased its electricity from the Union Electric Light & Power Company, distributing this energy for resale among its customers over its own lines, which penetrate principally the north and west sections of the city, paralleling in some cases the lines of the Union Company.

St. Louis County outside of the city limits is served by two associated supply companies, the King Electric Company and the Suburban Electric Light & Power Company, which sell electricity purchased from the Union Electric Light & Power Company among their customers in the suburban district surrounding St. Louis on the Missouri side of the Mississippi River.

As previously stated, St. Louis can boast of having had the largest arc-light station in the world, that of the Municipal Electric Lighting & Power Company, erected in 1889. As an example of the enterprising methods of the day, it is not without interest to refer to the history of this station. On Dec. 29, 1888, the municipality gave 10 days' notice to the Board of Improvements to prepare plans and specifications for lighting the city streets and public buildings with electricity, and then to advertise for proposals for 30 days in the newspapers of St. Louis, New York, Philadelphia and Pittsburgh, the contract to be awarded March 9, 1889. In accordance with this authority, three awards were made, one to the Missouri Electric Light & Power Company at $50,525 per year for incandescent lighting for public buildings and certain alleys in the southern district of the city; one to the Western Electric Company, of Chicago, which was assigned to the Laclede Gas Company, at $33,327 for similar lighting in the northern district. The main contract was awarded to Charles Sutter for the outdoor lighting of both the northern and southern district by the arc system, the aggregate being $166,439. When the latter contract was awarded the successful bidder had no organization and no plant, and but nine months remained in which to put the system into operation. In June the services of Mr. James I. Ayer were secured as general manager, work on the buildings and equipment was rushed with the feverish haste characteristic of the pioneer days of electrical development, and the new plant began operation promptly Jan. 1, 1890. The station thus hurriedly erected was a four-story building 100 ft. x 110 ft., of handsome architectural design, built of stone and pressed brick. As indicating the practice of the day, it may be stated that the initial equipment consisted of six 600-hp Corliss engines on the ground floor, each driving a line of shafting on the floor above, to which were belted the dynamos on the third floor. To transmit the 3600 hp generated at the engines, six 48-in. and 84 10-in. belts were required, each engine driving 14 60-light arc machines. The 19 boilers installed were of the upright type, and six were equipped for burning oil. The plant embodied many features of engineering design and operating detail in advance of current practice, which, combined with the size of the installation, made St. Louis at the time a Mecca for the central-station men of the country. Mr. Ayer, moreover, introduced thorough and systematic methods of operation, inspection and cost accounting, which also attracted wide attention and had much influence in displacing throughout the country the prevailing haphazard methods incident to an early period of rapid development.

When the alternating-current system reached a commercial stage, St. Louis was the first to take it up on a large scale. Having in 1889 been awarded a city contract for incandescent lighting, the Missouri Electric Light & Power Company, of which Mr. Herbert A. Wagner was superintendent, adopted the alternating-current system, and a few years later was operating a station supplying 80,000 16-cp incandescent lamps, forming then, and for some years later, the largest alternating-current system in the world.

Data as to the stage of St. Louis' electrical growth in 1893 are afforded in an address delivered before the sixteenth convention of the National Electric Light Association, which was held in St. Louis in that year. Mr. James I. Ayer, at that time president of the association, in the course of his presidential address, said that there were then in St. Louis 266 generators in central stations and various private plants supplying electricity to 185,000 incandescent and 5330 arc lamps, and a total of 1800 hp in generators supplying energy to 660 motors for almost every character of machinery. Nearly 60 sq. miles of territory was provided with arc and incandescent lamps. There were also 8240 hp in generators operating 1126 street cars over 160 miles of road, with 96 miles of road under construction, requiring 8000 hp in generators. The total generating rating at the end of the year would thus reach 30,000 hp.

UNION ELECTRIC LIGHT AND POWER COMPANY

ELECTRICAL GENERATION AND DISTRIBUTION

ELECTRICAL energy for lighting and motor service in the city of St. Louis and in St. Louis County, as well as a portion of the electrical consumption of the local street railways, is generated in the steam-driven central stations of the Union Electric Light & Power Company. There are three of these plants, the principal and largest being the Ashley Street station, which now has a total generating rating of 43,000 kw, and, as is at present contemplated, will shortly be increased to 78,500 kw. Nearby is the Lewis Street station, containing 6500 kw of steam-driven equipment. These two stations practically supply all of the energy for the system, as the third plant, the Tenth Street station, which contains 3000 kw in reciprocating engines driving direct-current generators, is maintained principally as a reserve, and is regularly operated only during the winter months when its exhaust steam is employed for heating.

The plants above enumerated were three of several central stations that formerly supplied electrical energy on a competing basis in St. Louis. The Lewis Street station was built in 1900 by the Laclede Power Company, while the Tenth Street station was the principal generating plant of the Imperial Electric Light & Power Company and was the first plant of the Union Electric Light & Power Company. The stations of the Missouri-Edison Company, formerly operated by the Union company, have since been closed down and dismantled.

The territory receiving energy from the Union Electric Light & Power Company is approximately 62 square miles in area, with a population of 800,000. The map on page 1273 shows the various kinds of electrical service furnished to the regions centering about the downtown district. The central station, bounded by Wash, Spruce and Adams Streets and Jefferson Avenue, is supplied with energy through underground circuits at 115-230-volt direct current on the Edison three-wire system. Outside of this section is a larger region in which 500-volt direct current is furnished overhead for motors. The outlying sections of the city, including all of the territory outside the direct-current Edison district, are supplied with 115-230-volt 60-cycle alternating current. For the transmission of energy to the seven substations of the system and to the four railway substations 25-cycle three-phase alternating currents at 6600 volts are employed.

The present commercial connection load of the system is about 70,000 kw in lamps, motors, etc. The United Railways Company of St. Louis takes, in addition, a maximum demand of 16,000 kw to assist its own generating stations. During 1909, the total energy output of the Union Electric Light & Power Company's system was 113,335,678 kw-hours, of which approximately one-third was delivered to the railways substations.

ASHLEY STREET STATION

The Ashley Street station, which is the main generating plant of the Union Electric Light & Power Company's system, is located at the Mississippi River foot of Ashley Street. Solid concrete foundations resting on bed rock carry the steel struc-

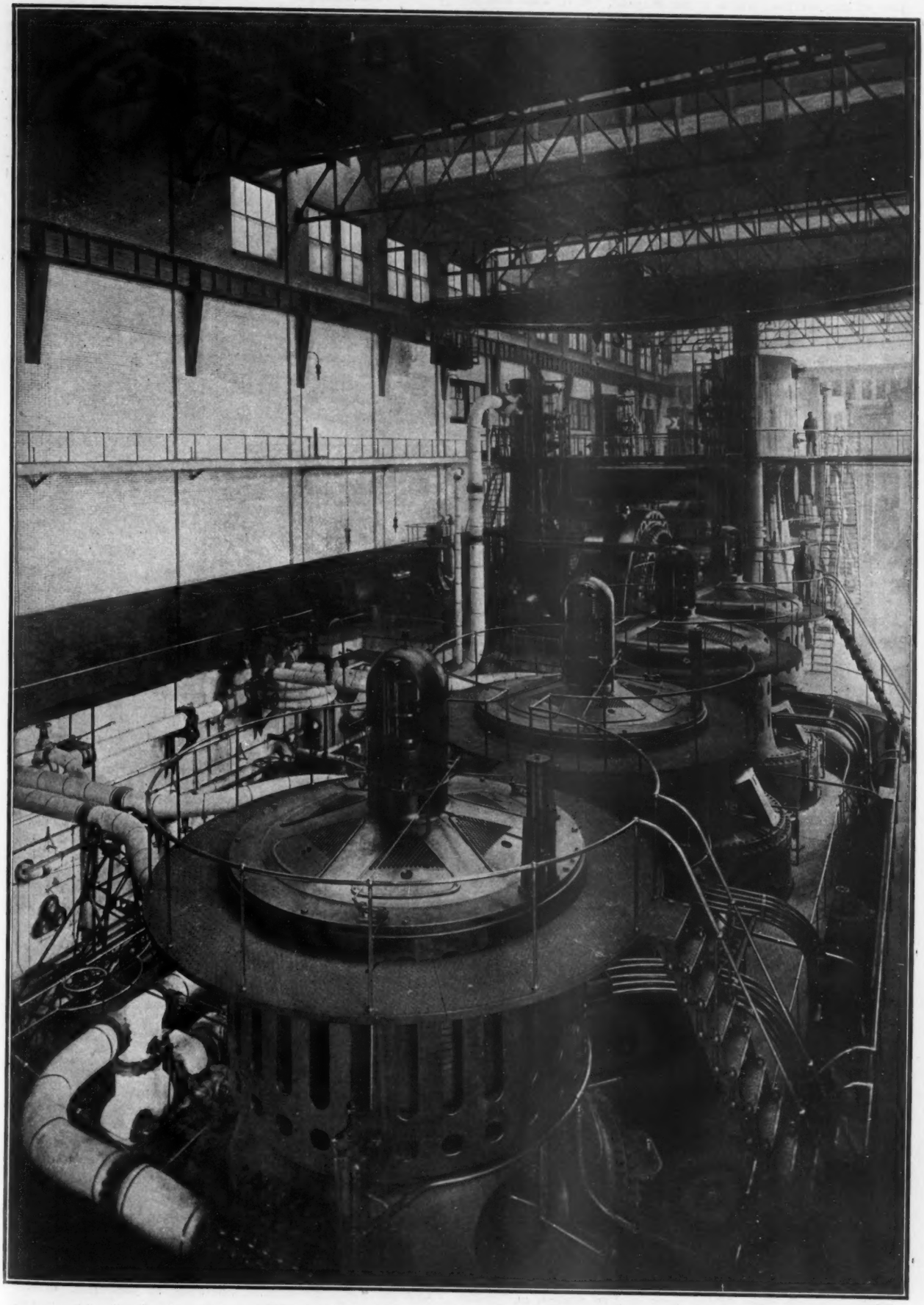


Fig. 2—Interior View of Ashley Street Station, St. Louis.

ture of the building, which is 320 ft. long, 176 ft. wide and 86 ft. wide. The exterior is of gray St. Louis pressed brick, ornamented with a colonade of Ionic columns which support arches and copings of terra cotta, lending an attractive architectural effect to the structure.

The engine-room interior is of white-enamel pressed brick down to a line 12 ft. above the floor, below this the lining is of brown enamel. The building is thoroughly fireproof, its roof and all floors being of reinforced concrete, window frames of metal and panes of wire glass.

The general impression created by an inspection of the interior of the plant is rather one of compactness in the arrangement of the large units it contains. This economy of space has been made necessary by the limited area, present and future, at the disposal of the builders of the plant. With the north and south lines of the station property definitely set by two city streets, its east wall on the river bank, and its west front abutting on railroad property, the present station, which occupies about one-half the ground plot, some time ago reached the limit of its expansion by the simple process of adding machines on the floor of the plant, so that present and future increments to the generating equipment are being worked out by the replacement of the existing apparatus with other machines of higher efficiency and larger rating. Later, the original plan will be carried out of duplicating the station building by extending it northward over the plant property at present occupied by a private railroad yard which provides switching and coal storage facilities.

Main Generating Equipment.—At the present time the Ashley Street station contains 11 main generating units, of which five are engine driven and six are turbine driven. The former comprise vertical Allis-Chalmers Reynolds Corliss cross-compound condensing engines, running at 75 r.p.m., and equipped with heavy flywheels, directly connected to Westinghouse 6600-volt, 25-cycle, three-phase alternators. Two of these units are of 1500-kw rating, the other three being 300-kw machines. All of the turbine-driven equipment is of the General Electric-Curtis type, with vertical-shaft rotors carried on oil step-bearings, and comprises two 2000-kw four-stage turbines, operating at 750 r.p.m., driving 6600-volt, 25-cycle, three-phase alternators; two 5000-kw four-stage turbines operating at 500 r.p.m., driving 6600-volt, 25-cycle, three-phase alternators; one 5000-kw five-stage turbine, operating at 500 r.p.m., driving a 2300-4000-volt, 60-cycle, three-phase alternator; one 12,000-kw

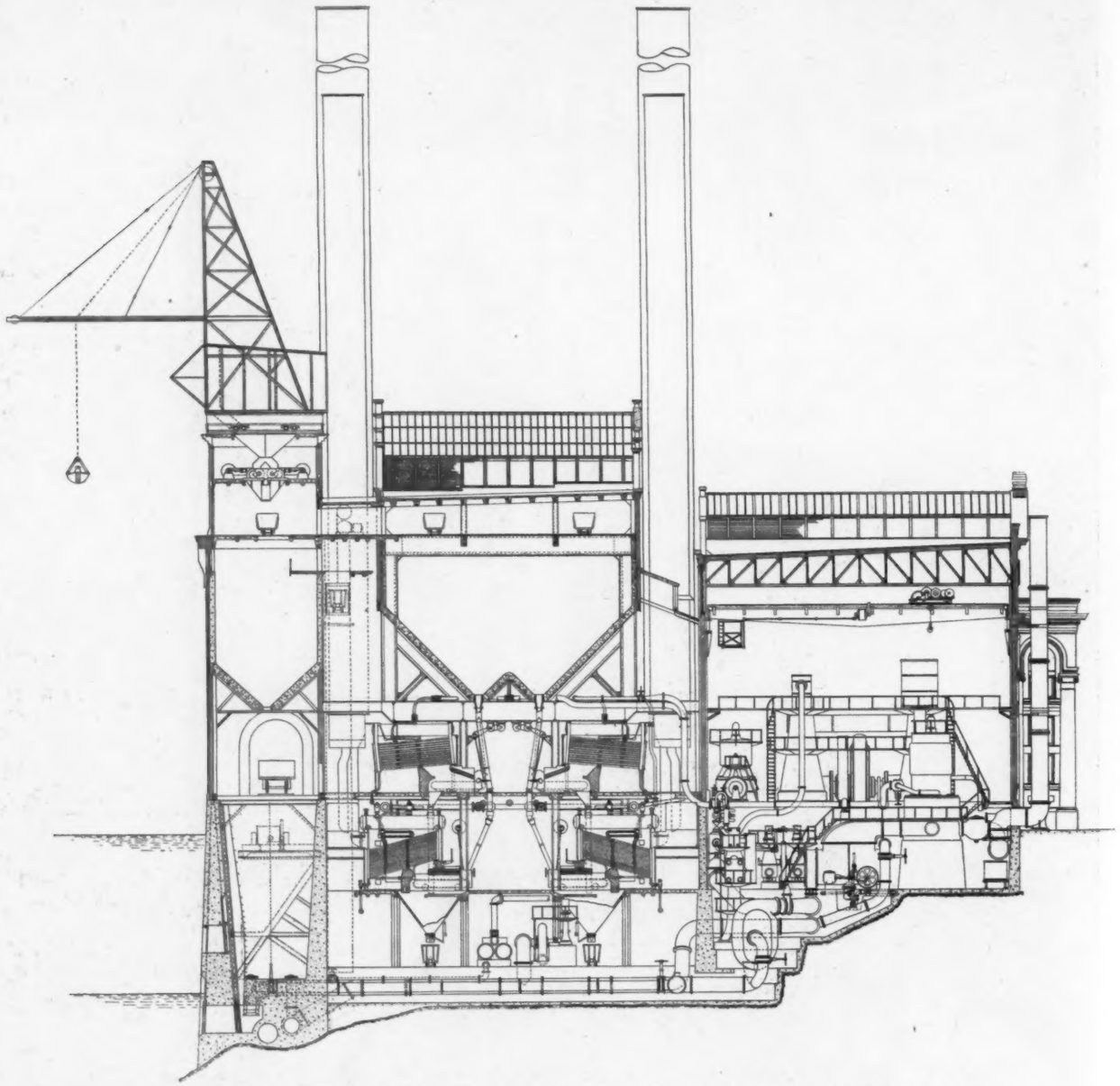


Fig. 3—Sectional Elevation Through North End of Engine and Boiler Rooms, Ashley Street Plant.

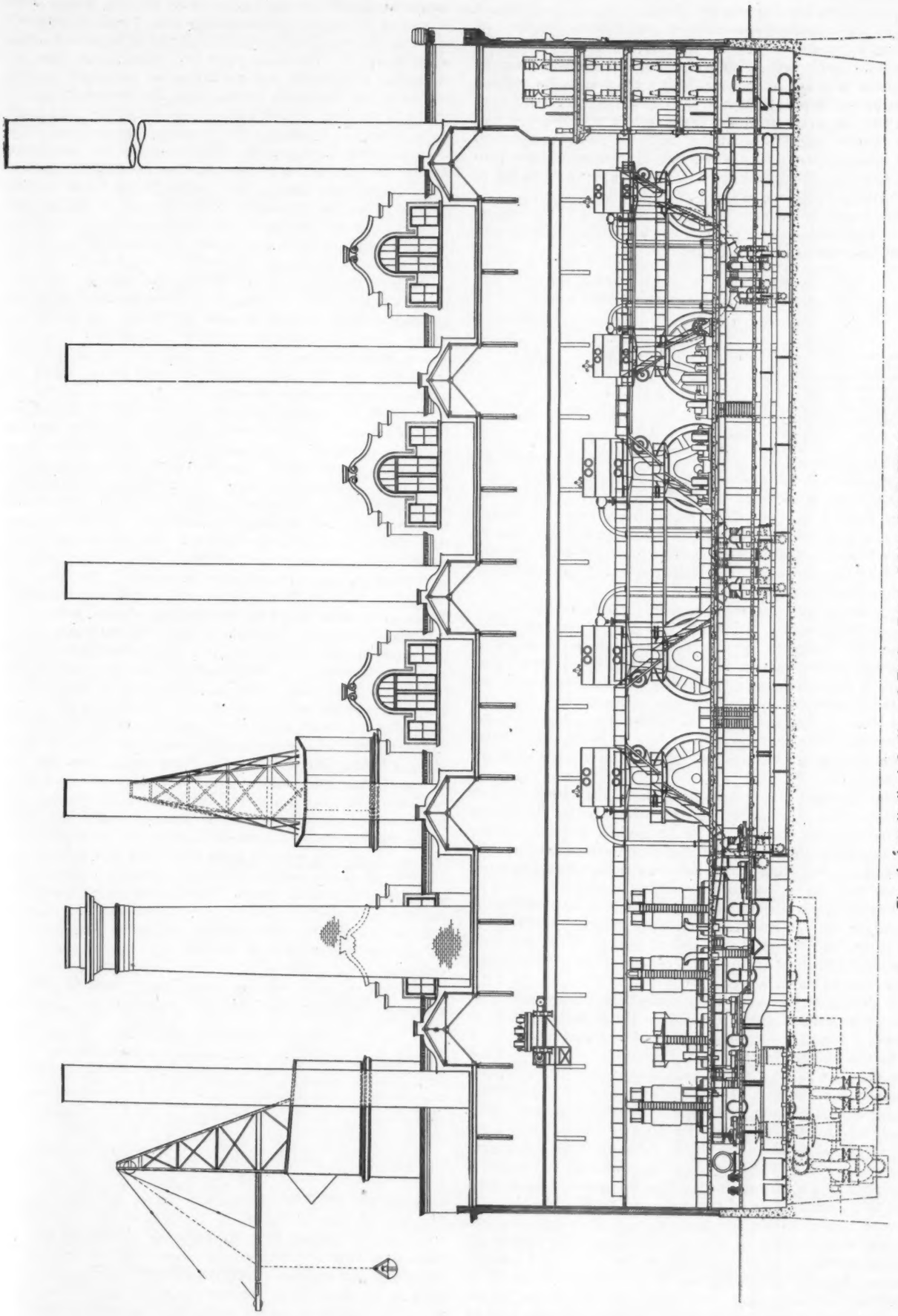


Fig. 4—Longitudinal Section of Engine Room, Ashley Street Station.

five-stage turbine, operating at 750 r.p.m., driving a 6600-volt, 25-cycle, three-phase alternator.

The last-mentioned unit has been only recently installed, replacing a 5000-kw 60-cycle set. By June, 1910, one of the 5000-kw 25-cycle units will be replaced by a 12,000-kw 60-cycle set on the same base, and by October, 1910, a third 12,000-kw turbine-generator is expected to be in operation, replacing another of the 5000-kw units. It is also contemplated to supplant one of the 1500-kw engine sets with a 12,000-kw turbo-generator, at the same time replacing the two 2000-kw turbines by two 3500-kw 60-cycle turbo-generators, thus bringing the total rating of the Ashley Street station up to 78,500 kw.

The engine-driven units occupy the south end of the engine-room floor, and are arranged in a line with their shafts parallel. Their dimensions are as follows:

TABLE I.—DIMENSIONS OF ENGINE-DRIVEN UNITS.

	3000-kw	1500-kw
Floor area, sq. ft.	31 x 46	25 x 38
Height, ft.	37.5	27
High-pressure cylinder, diam., in.	46	32
Low-pressure cylinder, diam., in.	94	64
Stroke, in.	60	60
Weight of fly-wheel, lb.	310,000	155,000
Weight of engine, lb.	1,200,000	600,000

Although the normal load of the 3000-kw units is 4600 hp, the engines are built to carry continuously a load of 7000 hp.

Occupying areas 17 ft. by 20 ft. each on the engine-room floor, opposite the two smaller engine-driven units, are the two 2000-kw Curtis vertical-type turbine-generators. The 8000-sq. ft. Wheeler surface-type condensers for these units are suspended below the floor level, and are served by motordriven wet and dry vacuum pumps.

The north end of the engine-room is occupied by the five larger turbine units. These are mounted, in line, on hollow concrete foundations, which allow free access to the step-bearings, while just east of each foundation, on the basement floor, is the corresponding condenser and auxiliary equipment. Each of these turbine units weighs, approximately, 275 tons. The shafts are 24 ft. long, 15 in. in diameter and weigh about 11,000 lb. The bucket discs are 12 ft. 4 in. in diameter, so that when running at 500 r.p.m. they reach a linear speed of 21,900 ft. per minute.

The condensing equipment of each of the larger turbines consists of a Worthington unit having 20,000 sq. ft. of tube surface, a 12-in. x 24-in. x 18-in. horizontal steam-driven dry vacuum pump and a 4-in. centrifugal-type wet pump, driven by a 15-hp, 220-volt, three-phase induction motor. The condensed steam from the turbines is returned to the hot wells.

The condenser apparatus for the engines is of the Wheeler admiralty surface type, each condenser contains 11,000 sq. ft. of surface for the 3000-kw units and 5500 sq. ft. for the 1500-kw units. Each equipment includes a bucket air pump driven by a vertical simple engine.

A 48-in. pipe, extending the length of the engine-room, provides free exhaust to the atmosphere for all turbines and engines, in case of accident to the condensing apparatus.

Station Water Supply and Purification.—Condensing water for the plant is taken from the Mississippi River through two wells in the sea wall, at the northeast end of the building. These intakes are protected from drift material by steel piling. Each well has two openings, the top of the lower gate being 2.3 ft. below the zero stage of the river, while the upper gate, 20 ft. above this, is used during higher stages. Each inlet is protected by a coarse strainer of 6-in. I-beams on 8-in. centers, and by a double screen of 1-in. wire mesh, which latter may be hoisted to the surface for cleaning. These intake wells lead to the suction pipes of five large steam-driven centrifugal pumps capable of delivering 175,000,000 gal. per day, a quantity several times that pumped by the St. Louis water-works. Two of these circulating pumps have 45-in. outlets, and can deliver 70,000,000 gal. during each 24 hours, against a pressure head of 40 ft., when running at 100 r.p.m. Each is driven by an 800-hp steeple-compound Corliss engine, built by the Fulton Iron Works, of St. Louis. The pump impellers, which are designed to act as flywheels for the engines, are 11.5 ft. in diameter, and weigh 36,000 lb. The other three circulating pumps have 30-in. suction connections, and are driven by four-valve vertical engines. The circulation water from the condensers is returned to the river through a 48-in. pipe, discharging at a point about midway of the river wall. Provision has also been made for conducting the condenser water to empty into the intake wells to prevent freezing of these passages in very cold weather.

The boiler water used at the Ashley Street station is also obtained from the Mississippi River, the turbid, alkaline and impure water of this stream being treated by a clarifying process of sedimentation which renders it admirable for boiler-feed purposes. Although the quality of the raw river water varies greatly during the year and with the stage of the river, an average test shows a gallon of it to contain about 35 grains of scale-forming substances and 350 grains of suspended matter, the latter making it very dark and turbid. There are also considerable impurities which tend to produce foaming or priming, and sufficient alkalinity to make its use, when untreated, inadvisable in the boilers.

Although the chemical methods of removing the impurities from the water are well known, their local practical working out in the treatment of large quantities for boiler-feed purposes has been accompanied by considerable original experiment by the Union company's engineers. A tap from the circulating pump intake supplies the raw, muddy river water to the mixing tank, where are added proper quantities of milk of lime and iron sulphate as coagulants and some soda ash to soften the water. These quantities are determined from careful analyses of the raw and treated water made twice daily. The tank containing the milk of lime is fitted with a mechanical agitator driven by a water wheel in the discharge stream, keeping its contents well stirred. From the mixing tank the water passes to a series of nine settling basins. Each of these basins, which are formed between the river wall and the east wall of the building, is 25 ft. wide, 40 ft. long and contains 10,000 cu. ft. They are provided with baffles to arrest the flow of the water, increasing the length of the path, and thoroughly distributing the coagulant. The water passes through the entire series in about 4 hours. Much of the clarifying action takes place in the first basin. The addition of the lime to the water produces insoluble carbonates, which are carried down by the floccular precipitate caused by the iron sulphate, the principle being similar to that employed in the St. Louis water works for treating city water. In traversing the last basins of the series the water is filtered through two beds of excelsior which remove any silica that may be present. The weights of the charges of the chemicals used are determined by analyses twice daily of both the raw and the treated water. A regular 5-minute cycle of making the mixture is carried out, for simplicity, the chemicals being added to a known quantity of the water in about the following average proportions: Milk of lime, 7 grains per gal.; sulphate of iron, 2.5 grains per gal.; soda ash,

TABLE II.—ANALYSES OF WATER.

	River Water	Settling Basin
Total hardness.	247.5	92.5
Calcium.	167.8	68.75
Incrustants.	79.7	26.75

0.7 grain per gal. The chemist who makes the daily analysis instructs the man in the mixer room as to the exact quantities of each to use, these figures being in turn affected by allowances made for the discharge rate of the inlet pipe as indicated by the readings of a Pitot tube. Purification is complete in the sixth basin, the seventh, eighth and ninth basins being used simply as storage tanks. This purification plant has

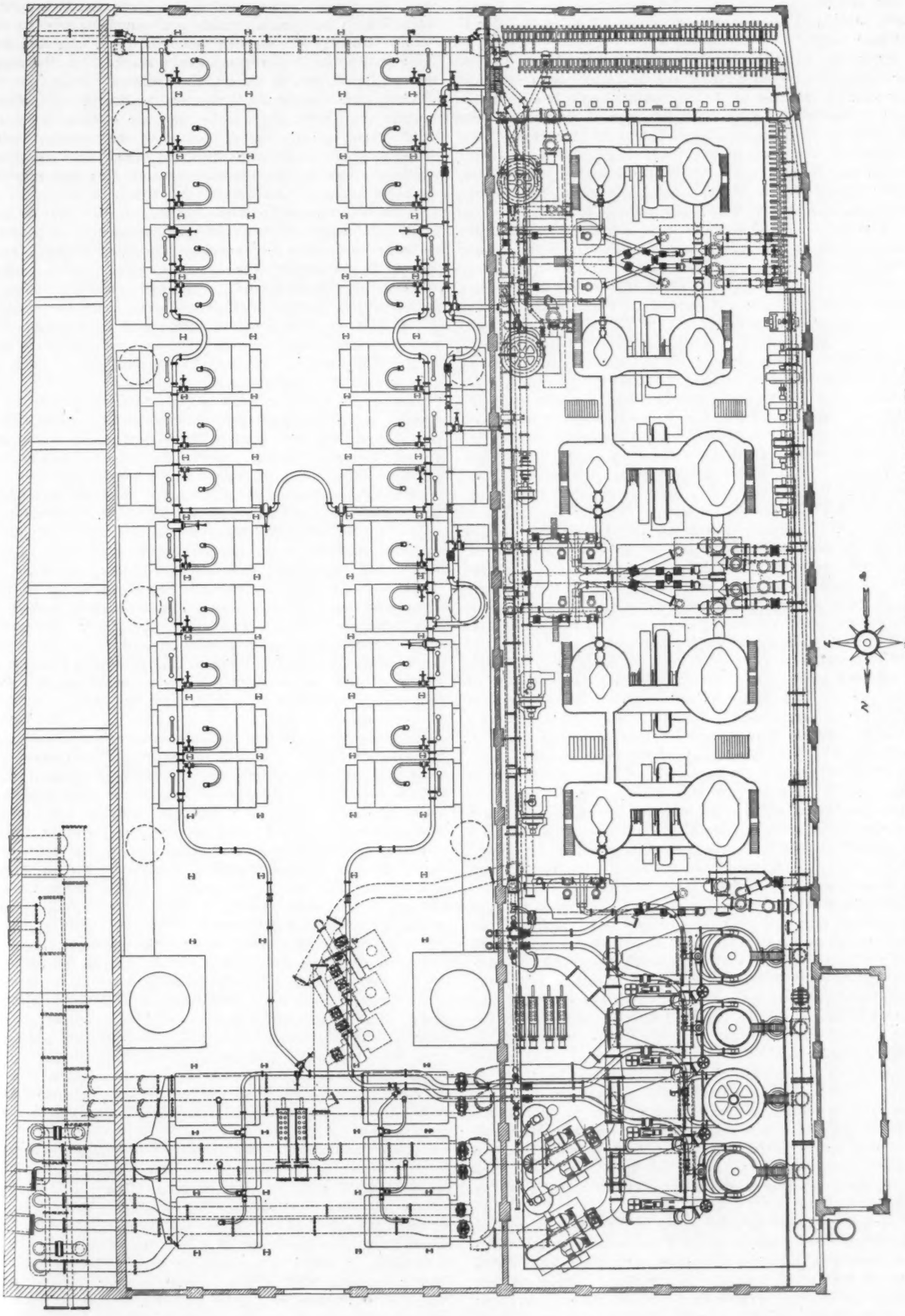


Fig. 5—Plan of Engine Room, Boiler Room and Settling Basins, Ashley Street Plant.

a rating of 150,000 gal. per day, and the water taken from it is clear and of excellent boiler-feed characteristics. A typical daily analysis of the raw and treated water is given in Table II on page 1262.

From the storage basins the treated water is led to the hot well, to which is also returned the condensed steam from the turbines. Connection to the city water supply is available in case of emergency. The water discharged from the hot wells is delivered by small centrifugal pumps to four Hoppe open feed-water heaters, heated by exhaust steam from the auxiliary apparatus. From these the feed water flows by gravity to the boiler pumps, one of which, located in the boiler-room sub-basement, is a horizontal compound-duplex pump, 18 in. x 34 in. x 17 in. x 24 in., having a rated output of 1800 gal. per minute, probably the largest boiler-feed pump installed in any generating station. In the engine room there are also two 24 in. x 14 in. x 24 in. horizontal duplex boiler-feed pumps, each having a rating of 1200 gal. per minute. Each pump is fitted with a pressure-controlling valve.

Boiler-Room Equipment—Coal Handling, Etc.—The steam-generating equipment comprises 68 boilers, 14 of which are of the internally fired marine type, and 54 of the water-tube type, having a total normal rating of 35,000 hp. The boilers are arranged in two decks of two rows each, the marine type boilers, which were the first to be installed, occupying the middle section of the lower deck. Each boiler fills a bay 15 ft. wide and 25 ft. deep. Those of the water-tube type contain 259 tubes, each 4 in. by 18 ft., and have a heating surface of 5260 sq. ft. Each of these boilers has its own superheater and generates steam at 184 lb. pressure, superheating it 70 deg. The furnaces are of the extended Dutch-oven type, and are equipped with Green traveling chain grates, presenting 105 sq. ft. of grate area. Eight self-supporting steel stacks, 10 ft. in diameter and 196 ft. high, and two 14-ft. brick stacks, 200 ft. high, provide an excellent natural draft for the fires. Two new 13-ft. steel stacks shortly to be added will be 250 ft. high.

Illinois coal, from the great bituminous fields near St. Louis, is delivered at the Ashley Street plant at an average cost of $1.15 per ton. A railroad yard north of the station has tracks for 35 cars; most of the coal is received in this way, although some has been delivered by barges on the river. A small switch engine, having 44-in. wheels and a maximum tractive effort of 12,500 lb., is employed for handling coal cars in the yard. To place the cars in position under the coal-hoisting mechanism, a small incline must be ascended on account of the height of the sea wall on which the tracks are laid. The cars are pushed up this incline by a small dummy car or "goat," driven by a 1.25-in. traction cable and a 0.75-in. tail cable, from the drum of a donkey engine. This dummy car runs on narrow-gauge track, and at the ground level is drawn into a pit between the standard rails, to permit the coal cars to be coupled to the switching locomotives. Cars with drop bottoms are dumped from the trestle into the coal pits beneath, from which a clam-shell bucket, controlled from an operator's gallery at the top of the building, hoists the coal 180 ft. to the hoppers in the coal tower. Standard cars are unloaded directly, by means of the hoist bucket, which removes from 75 to 80 per cent of the contents, the car being then passed to "trimmers" who shovel the remainder by hand into the pits, to be hoisted later. There are two of the coal towers, and each 1.25-ton bucket makes three trips per minute. The towers are pivoted and can be turned to any desired position, gathering from either the track, the pits, or barges on the river. Each bucket is under the close control of two operators, one manipulating the 100-hp hoist engine, the other the 25-hp trolley movement parallel to the boom.

After being dumped into the hopper in the tower, the coal, if of proper size, is by-passed around a crusher and delivered into 3-ton dump cars on an industrial cable railway which is trestled along the top of the two overhead bunkers. These concrete bunkers are just above the boilers, and can store about 15,000 tons. The larger bunker, containing 12,000 tons, is 210 ft. long, 40 ft. deep and 60 ft. wide. As an aid to localizing any fire that may be produced by spontaneous combustion in the coal, which is relatively high in sulphur, this bunker has been divided by bulkheads into seven sections each supplying coal to two bays of boilers. The smaller bunker is 45 ft. long and contains 3000 tons. From the bunkers the coal is discharged through downspouts to the automatic stokers.

Ashes from the furnace grates are discharged into hoppers beneath the boilers, from which they are collected by small cars. These cars are run to the end of the building, loaded onto one of two platform elevators, and raised to the top of the building, where they are dumped into ash bins whose spouts discharge into empty coal cars on the track beneath.

In the downspouts from the hoppers beneath the furnace grates have been inserted special balanced dampers which automatically close these spouts against the upward draft superinduced by the stacks. The downward passage of the ashes, however, is not impeded, as a very small quantity is sufficient to overbalance the counterweight, thereby opening the damper.

The boiler-room is provided with signal lamps, controlled from the engine-room, thus indicating what units are operating. The total demand on the station is also indicated to the firemen by a large station-type voltmeter, the scale of which is so marked that the pointer reads in "kilowatts" the setting of a rheostat handle manipulated by the switchboard operator. By this scheme the operator sums up the wattmeter indications, on both the 60 and 25-cycle circuits, and thus transmits an approximate estimate of the demand to the boiler-room, where it is of material assistance to the firemen in obtaining good pressure regulation. An intercommunicating telephone system and a local circuit, including ship-type loud-speaking instruments, are also provided for the transmission of intelligence to the boiler-room from several stations scattered over the plant.

For making tests on the coal offered for use in the Ashley Street plant, a pair of water-tube boilers on the upper deck have been especially fitted up with every facility for conducting accurate and complete investigations. Special inspection doors are provided, pressure tubes lead to the various draft passages, platform scales for weighing coal are arranged handily, and two 1000-lb. calibrated containers, with receiving tanks are mounted nearby.

The house-service pumps, which are steam driven, can deliver 300 gal. per minute. Beneath the entire station there is a sump into which there finds its way whatever drainage and leakage occurs from the various equipment. This sump is normally emptied by two 10-in. pumps, each having a rating of 2800 gal. per minute, one motor operated and the other steam driven, an emergency connection is also made to the suction of one of the 30-in. circulating pumps. Compressed air for blowing, cleaning and construction purposes above the station is supplied by two steam-driven air compressors, each handling 350 cu. ft. of free air per minute.

A complete survey of the various drops in steam pressure interposed by bends, valves and certain definite lengths of straight headers in the high-pressure piping, which admits steam to the units, is now being undertaken at the Ashley Street plant. A capillary U-tube, with arms 22 in. long, 0.5 in. in outer diameter and 0.09 in. in bore, is half filled with mercury or carbon tetrachloride, and the ends connected through tubes to taps at the points between which the pressure is to be measured. This simple means has secured some valuable data on the location of unaccounted-for drops in pressure in the steam piping.

Important auxiliaries of the Ashley Street station equipment are the well-equipped machine and forge shops, housed in adjacent buildings on the plant property. The machine shop contains the usual complement of lathes, shapers, drills, grinding machines, universal millers, pipe machines, etc., although the largest item of its equipment, a 25-ft. lathe with 46-in. swing, is installed on the main engine-room floor. The blacksmith shop is equipped with a steam-driven hammer, forges, etc. With the above-mentioned tools, all ordinary jobs of repairs are completed without recourse to outside help.

Switching and Auxiliary Electrical Apparatus.—For supply-

ing excitation current to the 43,000-kw equipment of alternating-current generating machinery before mentioned there are in operation four 100-kw, 800-amp, 125-volt, direct-current generators, two of which are driven by 150-hp Buckeye steam engines at 250 r.p.m., and the other two by Westinghouse three-phase induction motors at 480 r.p.m. To serve the future increase in generating equipment, there has also just been installed a 300-kw, 125-volt, six-pole, horizontal-type General Electric-Curtis turbine-driven exciter, running at 1500 r.p.m. A 75-cell battery, which is used as auxiliary to the excitation equipment, is connected to the float on the exciter bus and has a discharge rate of 1500 amp for 1 hour.

The electrical switching and control apparatus is mounted in a five-story fireproof gallery at the south end of the engine-room. This switching structure is of steel, gray brick and alberene stone, and is entirely enclosed in glass. On the top floor, in full view of the engine-room floor through glass windows, is the operator's position at the main switchboard. Here are located the generator panels, control pedestals, control board, various instruments, auxiliary busbars, generator oil switches and high-tension feeder panels. On the next or fourth floor are the main busses, generator disconnecting switches and ground detectors. On the third floor are the motor-driven generator field rheostats, feeder selector disconnecting switches, feeder non-automatic oil switches and the series transformers for the instruments on the top floor. On the second floor or engine-room level are the automatic feeder oil switches, the shunt transformers for the feeder instruments, series transformers for overload relays and the switchboard for the control of auxiliary apparatus. On the mezzanine floor, immediately below, are the high-tension busbars and step-down transformers for auxiliary apparatus, and the various generator cables, feeder cables and exciter cables, which are gathered together and led up to proper places on the brick switchboard structure above.

The generator leads pass through the engine foundations, and through conduit under the floor, to the columns supporting the switchboard. At the third floor they terminate in a pothead and are carried to the generator oil switches. Each generator is equipped with the three oil switches, one main switch and two selector switches. The selector switches are electrically interlocked and are connected to the main busbars through hook disconnecting switches. All the governing apparatus, such as oil switches, field circuit switches and rheostats, is controlled from pedestals on the top gallery, each generator having its own pedestal. The control wiring and the instrument wiring for all feeders and generators is increased in iron pipes brought above the top gallery and thence down to the pedestals, a construction which renders them readily accessible. To facilitate communication between the switchboard operators and the engineers on watch, a loud-speaking telephone of the marine type, mounted on the control gallery, connects to five similar instruments, four in the engine-room and one other in the boiler-room. Signal circuits to the boiler-room, controlled from this point, indicate, by lighting lamps, what units are operating; and an approximation of the total load on the station at any time is transmitted to the fireman by means of a rheostat, manipulated by the operator, which controls the needle of a special-scale voltmeter indicating the station load in kilowatts. There are also a private inter-communicating telephone system connecting all substations, and instruments connecting with the company's branch exchanges of the city telephone systems. Ordinary communication between operators and engineers is carried on by the use of signaling devices similar to the "bridge telegraph" used on board ship, giving such orders as "start engine," "thrown on excitation," "full speed," etc. The signals are controlled electrically and are both audible and visual.

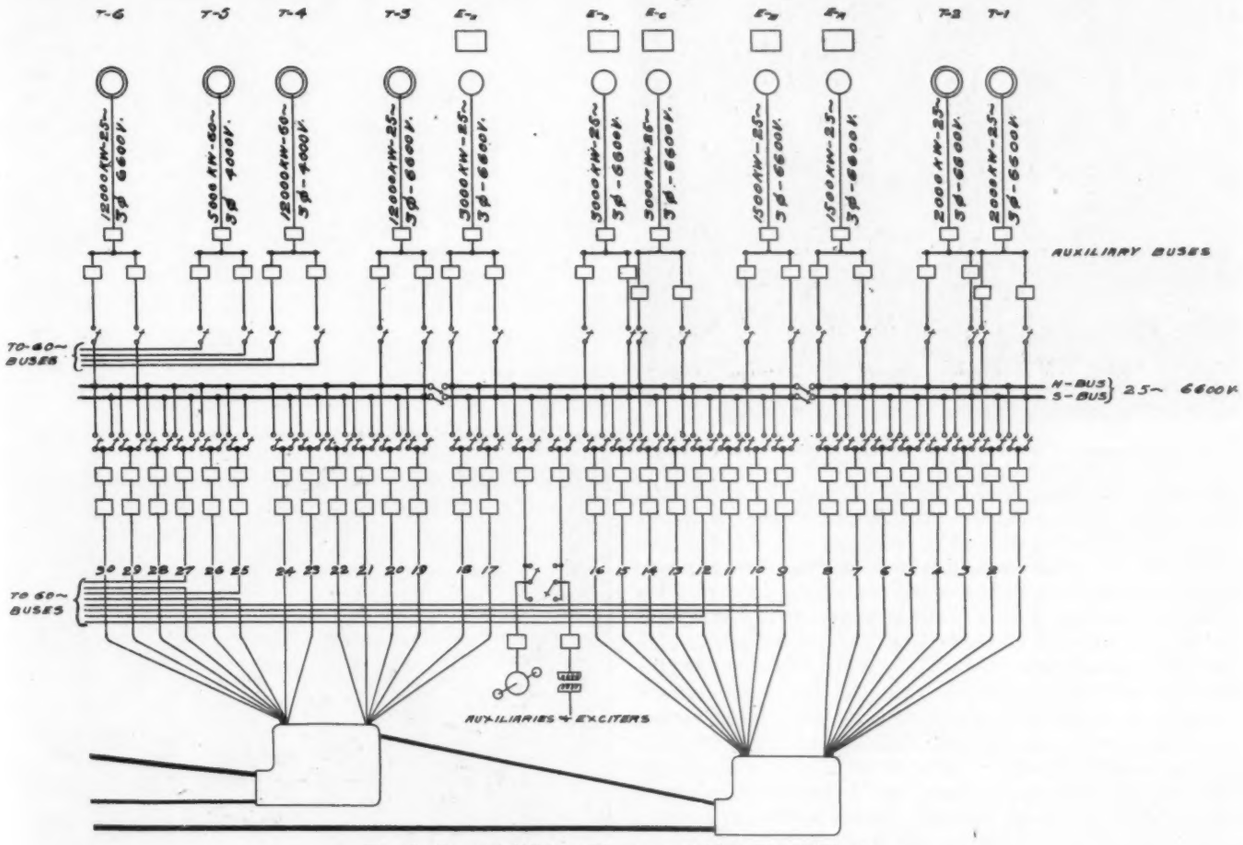


Fig. 6—General Wiring Diagram, Ashley Street Plant.

The outgoing lines from the Ashley Street station comprises six No. 4-0 three-conductor, 60-cycle feeders, and 30 No. 4-0 three-conductor, 6600-volt, 25-cycle feeders, four of which are convertible for use as 60-cycle feeders. The latter are tied

through from the 60-cycle buses of the Lewis Street station nearby, the dispatching and regulation of the 60-cycle load being controlled from the Ashley Street operating switchboard.

The Ashley Street station also contains substation No. 6, an enumeration of this equipment being given under appropriate heading in the description of the distribution system, which follows as a part of this article.

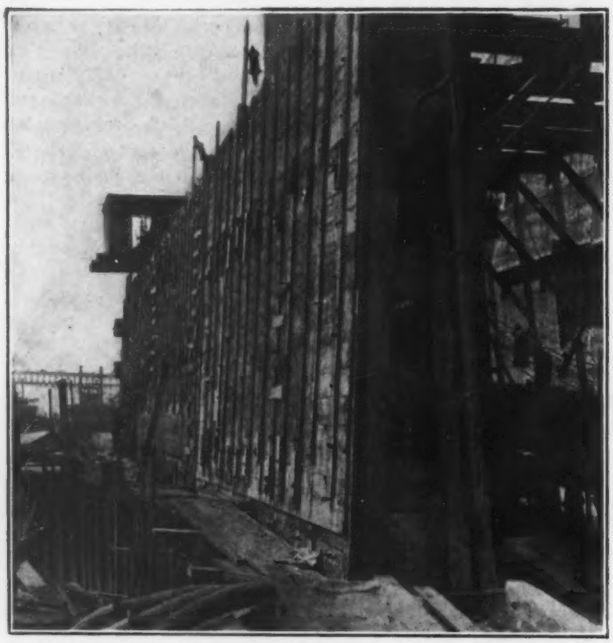


Fig. 7—Construction View of Sea Wall at Ashley Street Station.

Building the River Wall.—One of the most interesting features in connection with the Ashley Street plant was the building of the outer river wall, which forms one side of the settling basins for the boiler-feed purification system. The construction of this concrete wall, foundationed on the solid rock beneath the river bed, was an extremely difficult and hazardous undertaking. Several contractors had previously attempted the work but without success, so it was finally decided that the company itself should undertake the task. The exercise of unusual patience and engineering skill, extending over several years, finally overcame the many difficulties and obstacles, both anticipated and unforeseen, which were met in this work, and the wall was successfully completed early in 1906. The structure is 325 ft. in length, being built out into the river approximately paralleling the shore. At each end it closes to the building wall, at a distance of 18 ft. at the south end and 32 ft. at the north end.

As shown in the accompanying illustrations, interlocking steel piles, 50 ft. in length, were first driven to rock, forming a cofferdam. The site had been previously occupied by a grain elevator, and it later developed that as the result of a fire years before, a number of barges tied up alongside the elevator had been sunk. In the work of excavation it was found that the steel piling instead of going to rock had been driven into some of the round wooden elevator piling and into the sunken wreck, parting the steel piles so that they no longer interlocked. This condition caused heavy leaks into the cofferdam, which seriously retarded the work.

The base of the building wall is at a level 10 ft. below the zero stage of the river, from which point the rock slopes off very abruptly to a point 25 ft. below the zero stage at the base of the outer or river wall, the base of the piles going to a level at from 27 ft. to 30 ft. below the zero stage of the river. On account of the tremendous river pressure against the cofferdam, it was found impracticable to work within the cofferdam with a river stage above 10 ft., which at the base of the piling, extending approximately 27 ft. below zero stage, represented a head of from 37 ft. to 40 ft. It was, therefore, possible to work only during the winter months while the river stage was low.

The excavation throughout all of this work was carried clear to rock, and the latter was then blasted to form horizontal steps to afford a good footing for the concrete. Dowel pins 3 ft. in length and about 2 in. in diameter were sunk to half their length into the rock in order to give good adhesion to the concrete. In this manner a solid block of concrete, measuring 10 ft. in depth close to the building wall and 25 ft. in depth at the river side, and varying in width, depending upon the point of section, forms the base from which the outer wall tapers upward a height of 50 ft., as shown in Fig. 8. This concrete serves as the river wall of the settling basin, the bottom of the basin being at a height representing the zero stage of the river.

The accompanying illustrations are indicative of some of the hardships encountered in this work. Flooding was frequent, due to many causes. Fig. 8 was taken immediately after the ice in the river had broken, the river having been previously frozen over for an entire month. The ice packed or gorged several miles down stream, the river rising very suddenly, causing the entire cofferdam to be flooded, and the temporary suction intake to the plant to be crushed and carried away.

Fig. 10 shows one of the means devised and resorted to by Mr. W. V. N. Powelson, who was then general manager and had active charge of the work, in stopping excessive leaks, the gaps under water being closed off by producing large masses of ice across the openings. The local refrigeration was supplied by liberating ammonia gas under pressure, delivered from an ice plant nearby, from nozzle pipes thrust down alongside the gaps.

Fig. 8 shows a portion of the wall completed and indicates the shape given by steel "A-frames" which are imbedded in the concrete. T-rods shown projecting from the end of the wall

Fig. 8—Typical Damage to Sea Wall Construction Due to Ice-Jam and Rise in River.

continue throughout its length and are tied together from section to section by means of turn buckles.

From the sections of the wall near the intake, as shown in Fig. 9, it was found impossible to accomplish the work in the manner previously described. Here the lower block of concrete forming the base of the wall was installed by means of a caisson, measuring 50 ft. by 16 ft. The section shown formed the extreme northeast corner of the wall. The two sections

immediately south of this point were also installed by the caisson method. The balance of the wall, approximately 225 ft. in length, as well as the portion of the wall close to the building, was installed by means of the cofferdam method.

The major portion of the construction of this sea wall was carried out under the personal supervision of Mr. Herman Spoehrer, then superintendent of construction at the Ashley Street station and now secretary and treasurer of the Union Electric Light & Power Company.

LEWIS STREET STATION.

The Lewis Street station, which is also located near the west bank of the Mississippi, a short distance north of the Ashley Street station, is a red brick structure, 240 ft. long, 80 ft. wide and 54 ft. high, surmounted by five 150-ft. stacks. The engine-room floor is excavated into the rock, 19 ft. below the street level.

The Lewis Street station contains three Hamilton-Corliss cross-compound condensing engines, each directly connected to a 550-kw, 500-volt, General Electric direct-current generator running at 100 r.p.m.; two Curtis vertical-type, two-stage turbines, driving General Electric 500-kw, 2300-volt, 60-cycle, three-phase alternators, operating at 1800 r.p.m. and equipped with oil step-bearings and hydraulically operated valves, and two Westinghouse-Parsons horizontal-type turbines, driving 2000-kw, 4500-volt, 60-cycle, three-phase alternators, running at 1200 r.p.m.

Excitation for the above machines is commonly supplied from the Ashley Street exciter buses over a 1,000,000-cir. mil, two-conductor cable tie-line, but the Lewis Street station also has independent exciting equipment, comprising a 20-kw, 125-volt, Northern direct-current generator, driven by a DeLaval steam turbine and a 100-kw Westinghouse motor-generator set, receiving energy from the 60-cycle, 4000-volt buses.

The steam-generating equipment consists of three 400-hp and eight 500-hp Heine water-tube boilers, with hand-fired furnaces

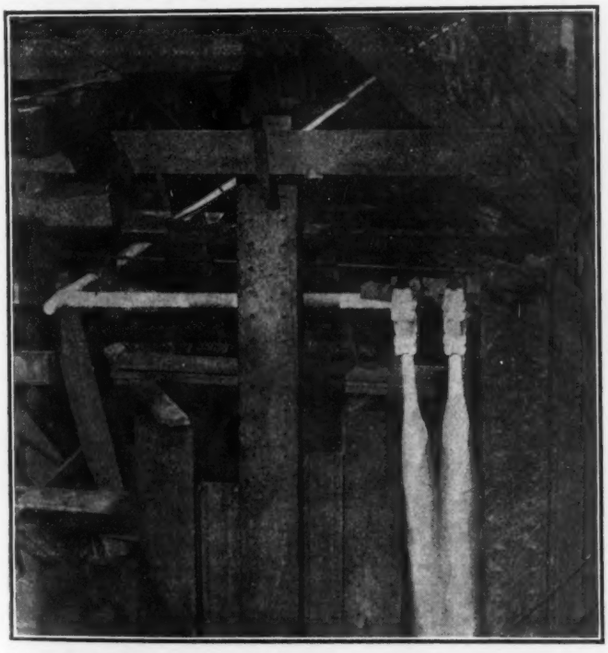


Fig. 9—Compressed Ammonia Pipes Used to Close, By Freezing, Submerged Gaps in Cofferdam Piling.

and one economizer to each boiler. The settings for four of these boilers are entirely of reinforced concrete, including the main breeching into the economizer. There are five steel stacks, each 7 ft. in diameter and 150 ft. high, except the south stack, which is 135 ft. in height.

Boiler-feed water piped from the purification plant in the Ashley Street station is handled by three Worthington 12-in. x 7-in. x 15-in. duplex and two 14-in. x 9-in. x 20-in. Simplex boiler-feed pumps, after traversing a Cochran feed-water heater.

Circulation water for the condensers is taken from the Mississippi River through two 380-ft. tunnels, each 8 ft. square in cross-section, extending out into the stream bed and containing the suction and discharge conduits to the condenser system. The intake pipes open under the gravel bed of the river, which acts admirably as a filter. The pump-room containing the five

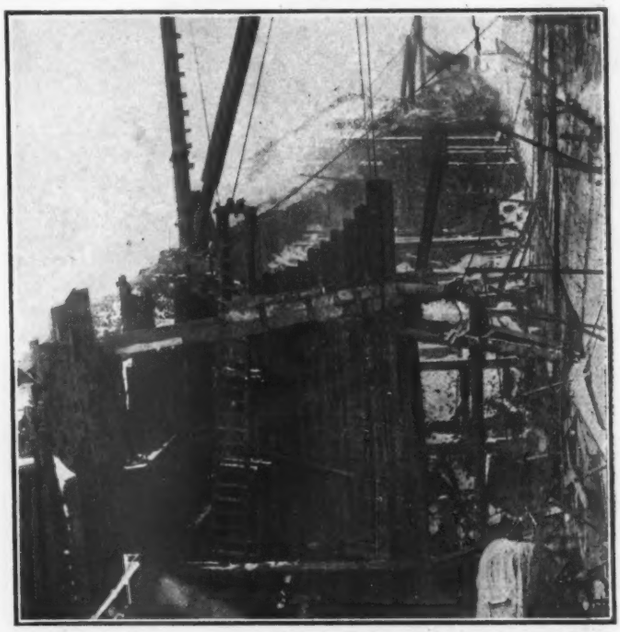


Fig. 10—Use of Caissons in Constructing Ashley Street Sea Wall.

circulation pumps is a chamber excavated out of the solid rock 46 ft. below the street level, and is ventilated and reached by narrow shafts at either end, one of which contains a spiral stairway. The two pump sets at present in use are Wood 24-in. centrifugal units driven by Hamilton-Corliss 10 in. x 20-in. x 24-in. tandem-compound engines, while two 12-in. centrifugal pumps, driven by 7 in. x 13-in. x 8-in. steeple-compound engines, are maintained in reserve.

At the west side of the engine room is the 2300-4000-volt, 60-cycle switchboard tying to the Ashley Street buses, and the 500-volt direct-current board feeding energy into the local network. Two groups of transformers totaling 900 kw in combined rating are installed in the leads of the 500-kw turbine-generators, making available the output of these units for distribution as 4000-volt energy. Feeding directly out of the Lewis Street station are 18 No. 4-0 500-volt feeders, conveying energy to the 500-volt network.

TENTH STREET STATION.

The Tenth Street station, located at Tenth and St. Charles streets, directly opposite the offices of the company, is a three-story red-brick structure, occuping a ground area 235 ft. x 85 ft. Its main generating units consist of one 1000-kw Williams vertical compound marine-type engine, connected, by means of Arnold electromagnetic clutches, to two 500-kw Siemens & Halske, 500-volt, direct-current generators, and to two 600-amp booster machines; one 500-kw Williams engine, of the above type, similarly connected to a 500-kw, 250-volt Siemens & Halske direct-current generator, and one 1500-kw Fulton horizontal cross-compound engine directly connected to a 1500-kw, 500-volt Westinghouse generator.

The present station was one of two complete installations in this country of the magnetic-clutch connection invented by Mr. B. J. Arnold, who acted as consulting engineer for the Imperial Electric Company, which built this station. By a system of quills and internal shafts, connected by magnetic clutches, any of the generating units or boosters can be driven

by either engine during ordinary operation or in case of necessity. Changes in connections can be made while all the machines are in motion, it being simply necessary to bring a standing machine up to speed as a motor before throwing in the magnetic clutch. This system enables the selection of a limited number of generators for a given engine, and permits the remaining engines to handle the generator of any disabled engine.

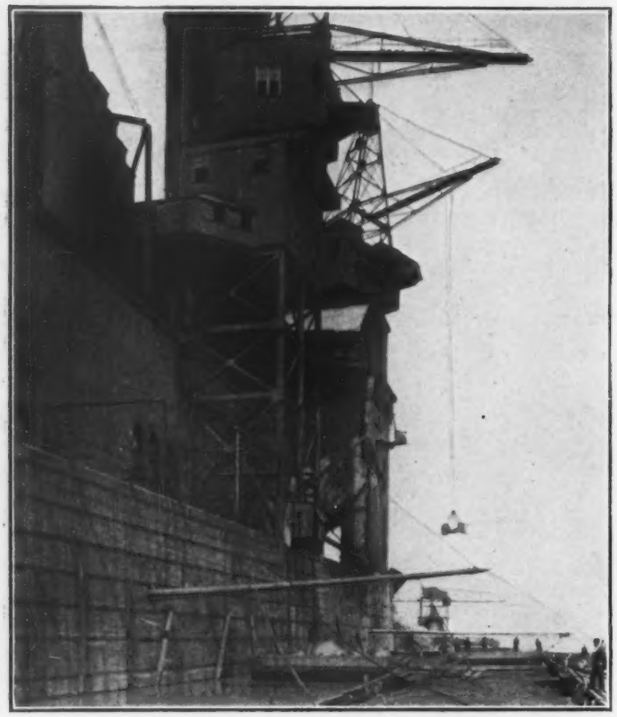


Fig. 11—Loading Coal from Barges, Ashley Street Station.

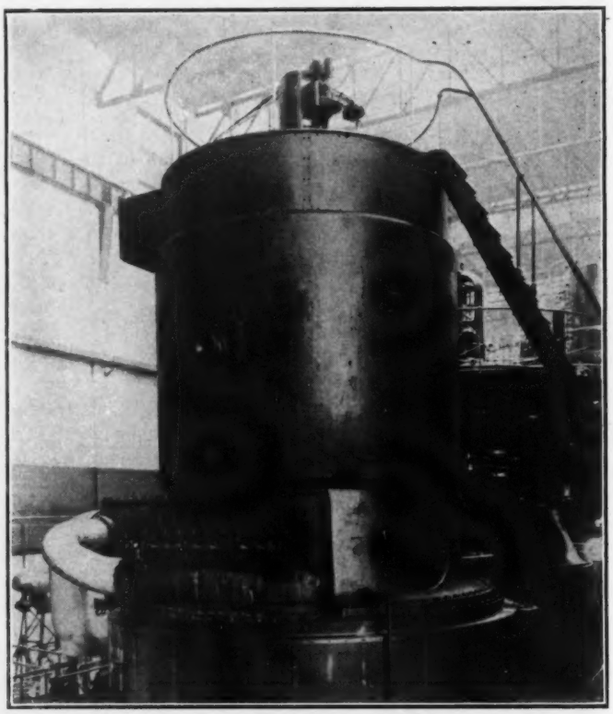


Fig. 12—12,000-KW Turbo-Generator, Ashley Street Station.

The steam-generating equipment of the Tenth Street station comprises 12 Heine water-tube boilers, four of 445-hp rating and eight of 360 hp. The condensing plant consists of a Worthington 3400-sq. ft. surface condenser and cooling tower, two air pumps and two rotary circulating pumps.

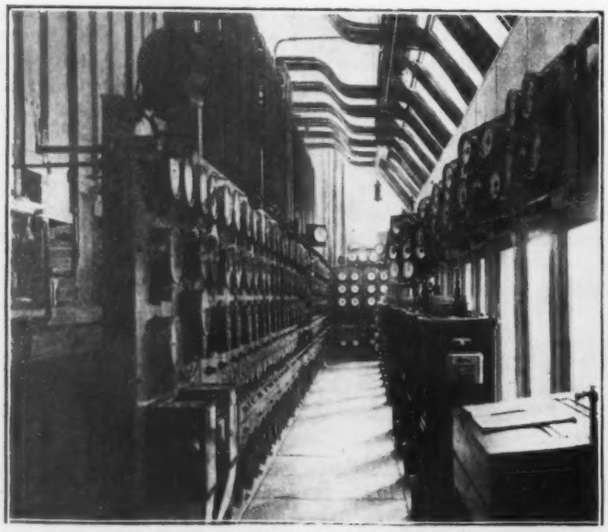


Fig. 13—Operating Switchboard Gallery, Ashley Street Station.

The switchboard equipment of the Tenth Street station is located in the overhead gallery of substation No. 3, which occupies a portion of the Tenth Street station building.

As before noted, the Tenth Street station is maintained chiefly as a direct-current reserve, in case of accident to the main station. Part of its equipment is regularly operated non-condensing during the winter months, however, when there is a demand for its exhaust steam for heating. For this service two 14-in. exhaust pipes carried in a 5-ft. underground tunnel supply steam heat to 16,000,000 cu. ft. of buildings located within a radius of 700 ft. of the engine-room.

Mr. John Hunter is chief engineer of steam-power plants for the Union Company, and is assisted by Mr. G. C. Vennum for the main generating station and by Mr. John Anderson, in charge of the steam-heating department and isolated plants.

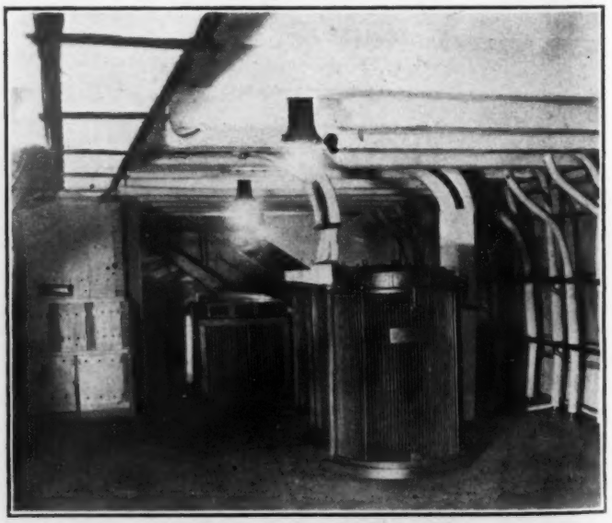


Fig. 14—Station Transformers in Ashley Street Station, Showing Method of Fireproofing Cables.

SUBSTATIONS.

The generating plants of the Union Electric Light & Power Company transmit energy to 11 substations, including the four converting stations of the railway company. The seven substations of the company are designated by numbers.

Substation No. 1 is located at 707 North Fourth Street, and supplies energy to a direct-current, three-wire Edison network in the underground district, in which it is situated. The building is a one-story structure of buff brick, and externally presents an appearance of much dignity. The interior walls are lined with white-enameled brick and the floor is of tile. Along the left wall, as seen on entering, are ranged the high-tension switches, mounted in separate brick compartments. At the right is the switchboard gallery.

The station contains three 1050-kw National motor-generator sets, comprising 6600-volt, 25-cycle, three-phase motors driving 230-volt direct-current generators. Space remains in the station for three similar motor-generator sets. An equalizer set, consisting of two 100-kw, 115-volt National machines, is arranged to compensate automatically for unbalancing in the three-wire system. A three-unit Western Electric booster set is also provided for raising by 60 volts the pressure on each side of the three-wire system when carrying 1350 amp in the outside wires. In the substation basement there is a storage battery of 170 chloride accumulator cells, having a maximum discharge rate of 3456 amp for one hour. The battery is controlled by four 30-contact end-cell switches and floats on the bus at all times except during charge, and in such case the advantage of continuous floating is maintained by means of automatic circuit-breakers in the booster circuits which act to close switches connecting the end-cell switches to the buses with any predetermined number of cells in circuit.

Three No. 4-0, three conductor, 6600-volt, 25-cycle feeders enter substation No. 1, underground. Passing the first hook disconnecting switches these lines are led through motor-operated General Electric oil circuit-breakers equipped with reverse-power relays, through a second set of hook switches to the high-tension busbars. Each incoming line is provided with an ammeter and watt-hour meter operated through series and shunt instrument transformers. The buses are sectionalized by non-automatic remotely controlled oil circuit-breakers. From the 6600-volt busbars energy is led to the 6600-volt synchronous motors, through hook switches and automatic oil switches equipped with overload relays. These motors are provided with an alternating-current ammeter, direct-current ammeter in the field circuit, watt-hour meter, power-factor meter, and direct-current field-circuit switch, which are mounted with the oil-switch control apparatus on the operating gallery. The generators are equipped with single-pole, double-throw knife switches, built in two sections for easy manipulation and to permit the generators to be connected to either of the two direct-current buses which are provided for regulating the pressure at the end of feeders of varying length and loads. The generators are also provided with non-automatic remotely controlled circuit-breakers, located upon the machine bedplates. These circuit-breakers permit the quick and safe disconnection of the generator from the buses in emergencies

Fig. 16.—Lewis Street Generating Station.

when under load, and also act as a safeguard against error on the part of the switchboard operator should he attempt to connect a standing machine with the buses. Each generator is also provided with Weston edgewise voltmeter and ammeter, and a Thomson astatic wattmeter.

The units are started from the direct-current end, the synchronous motor being synchronized with the 6600-volt bus by the aid of a General Electric synchronism indicator and voltmeter mounted upon a bracket conveniently located. The battery switchboard equipment consists of two end-cell switch indicators, two ammeters, two sets of knife-selector switches, one bus voltmeter, one low-reading cell voltmeter, bus voltmeter switch, end-cell voltmeter switch, recording voltmeter, hydrometer signal and amp-hour meter for each side of the three-wire system. The pilot cell on each side of the battery

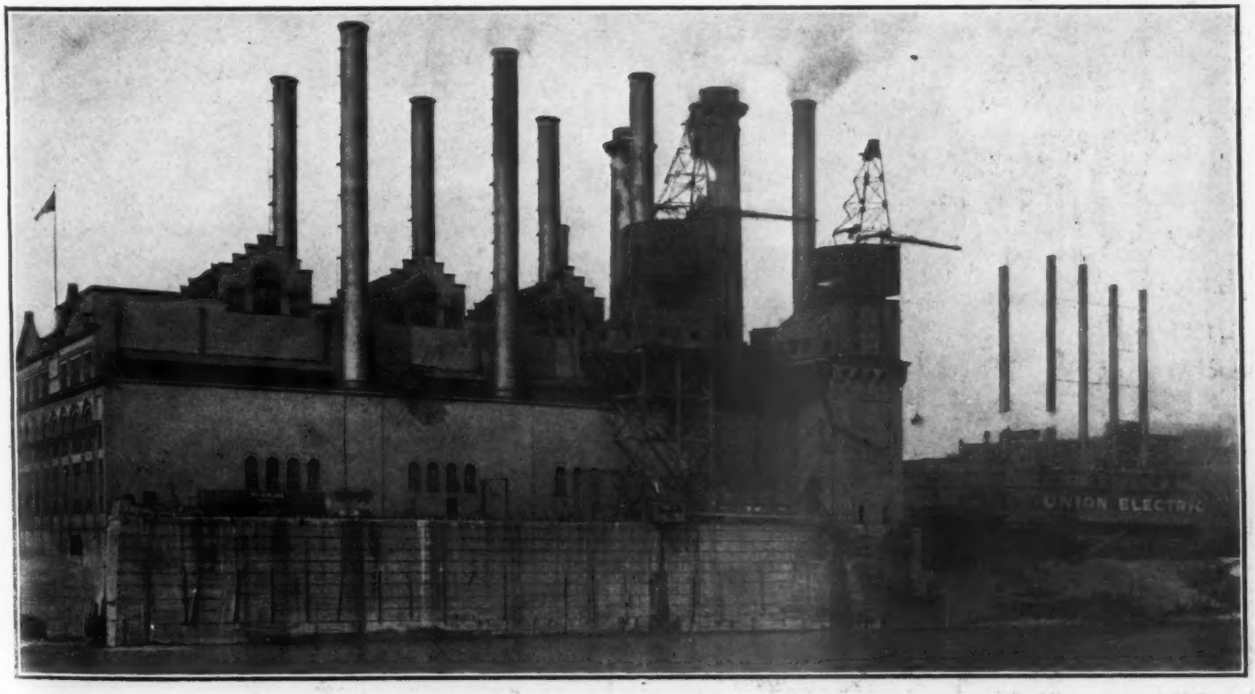


Fig. 15—Ashley Street and Lewis Street Generating Stations.

is equipped with an automatic cell-filling device and recording hydrometer with signaling connection to switchboard. The generator and motor panels are located at one end of the board, with feeder panels at the other end, the center space be-

Fig. 17—Exterior View of Substation No. 2

ing occupied by the battery panels. The direct-current output is delivered to the three-wire network through 12 230-volt feeders connected to the buses by single-pole, double-throw knife switches, and are provided with Weston edgewise ammeters in each outside wire. The feeder end pressure is ascertained by the aid of pressure wires brought back to the station from each feeder end, which are connected to two sets of illuminated-dial potential indicators through voltmeter switches. Eleven of the feeders have cross-sections of 1,500,000 circ. mils and one feeder 2,000,000 circ. mils.

Substation No. 2, which is located at 24 South Fourth Street, is identical with substation No. 1 in its alternating-current and direct-current equipment, with the exception that it has 13 1,500,000 circ. mil feeders. The building is similar in construction to substation No. 1, the principal difference being that it is 4 ft. wider and somewhat longer. Substations Nos. 1 and

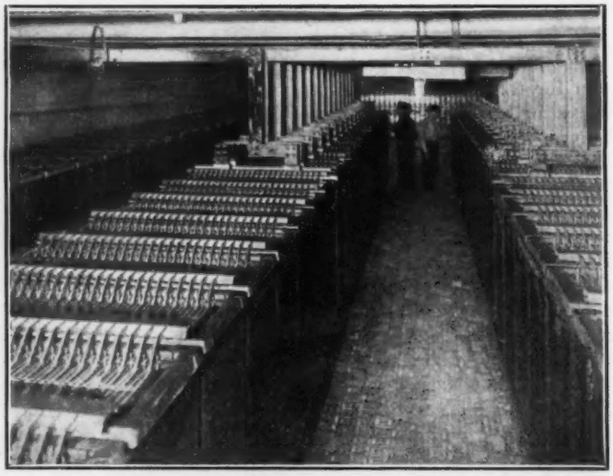


Fig. 19—Storage Battery, Substation No. 2.

2 are connected together and to substation No. 3 by 2300-volt tie-lines of 2,000,000 circ. mil cross-section.

Substation No. 3 is located at the southeast corner of Tenth and St. Charles streets, in the same building housing the Tenth Street generating station. This is the largest substation of the company and contains apparatus for receiving 6600-volt, three-phase, 25-cycle energy from Ashley Street and supplying it to the 115-230-volt and 250-500-volt, three-wire dis-

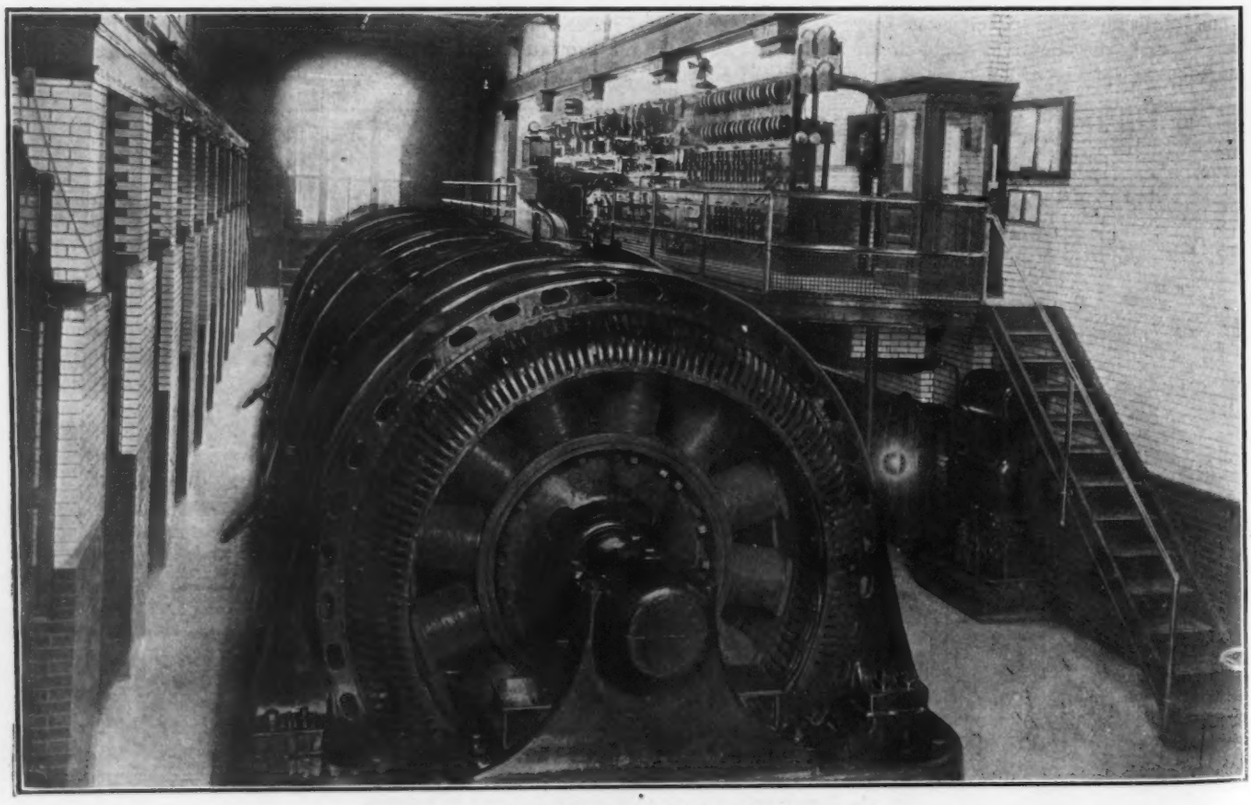


Fig. 18—Interior of Substation No. 2.

tribution systems. It also contains the greater part of the substation equipment for the series-arc street-lighting system.

The equipment of the station consists of five 1050-kw National motor-generator sets similar to those installed at substations Nos. 1 and 2, one 500-kw National three-unit motor-generator set having a 525-kw, 6600-volt, three-phase, 25-cycle synchronous motor, driving two 125-volt shunt-wound direct-current generators; two Westinghouse 25-cycle, 550-volt, 500-kw rotary converters, each receiving energy through three Westinghouse 187-kw, single-phase transformers and Westinghouse three-phase motor-driven remotely controlled induction regulators; one Westinghouse balancing set comprising two 50-kw, 250-volt, compound-wound machines on the same shaft; one Western Electric motor-driven three-wire booster set designed for 600 amp and 135 volts on each side; six three-unit arc-lighting motor-generator sets, each having one 200-hp, 500-volt Western Electric motor driving two 110-lamp, 6.8-amp Western Electric arc machines; five General Electric 6.8-amp, 75-lamp, 6600-volt, 25-cycle constant-current transformers with mercury-arc rectifiers; and three General Electric 4-amp, 75-lamp, 6600-volt, 25-cycle constant-current transformers and mercury-arc rectifiers. There is also installed in this station a chloride accumulator of 296 cells, which is floated on the 250-500-volt network.

The incoming feeders for substation No. 3 are divided into two groups, each taking a different route from the Ashley Street station to the substation. The feeders enter the basement from the street conduits and are carried up to the upper floor of the station to the high-tension switch structure, where they are arranged with relation to the high-tension buses in a manner similar to that in substations Nos. 1 and 2. The high-tension structure is located above the low-tension gallery and operating board, the operator having access to the high-tension structure by means of an iron ladder reaching from the floor of the gallery. The incoming lines and the motors and converters are equipped with switches, instruments and relays similar to those described for substations Nos. 1 and 2. The low-tension board and high-tension control bench are located on an enclosed gallery at one end of the combined engine-room and substation. The switchboard is arranged around the four sides of the enclosed gallery, with the bench control immediately in front of the windows overlooking the main floor of the station. The low-tension board is divided in the center by blank panels reserved for a large three-wire battery, all of that portion of the board to the left being of negative and to the right being of positive polarity. The generator-control devices for both the 230-volt and the 500-volt apparatus are kept on the negative side for the sake of convenience, the operator's desk being arranged to give him a view of all instruments from his seat. The eight potential indicators are located above the negative panels and immediately in front of the operator's desk. The generators and direct-current side of the converter and all outgoing low-tension feeders are equipped with the same instruments and switches as at substations Nos. 1 and 2. All cables and wires are carried in ducts wherever possible, and elsewhere are thoroughly fireproofed. The entire structure is fireproof, and no insulation except fiber or slate has been left exposed. Fig. 14 shows the manner in which the fireproofing is carried out.

The 115-230-volt network receives energy from this substation through 22 feeders, 19 having cross-sections of 1,500,000 circ. mils, the remaining three being of 2,000,000 circ. mils.

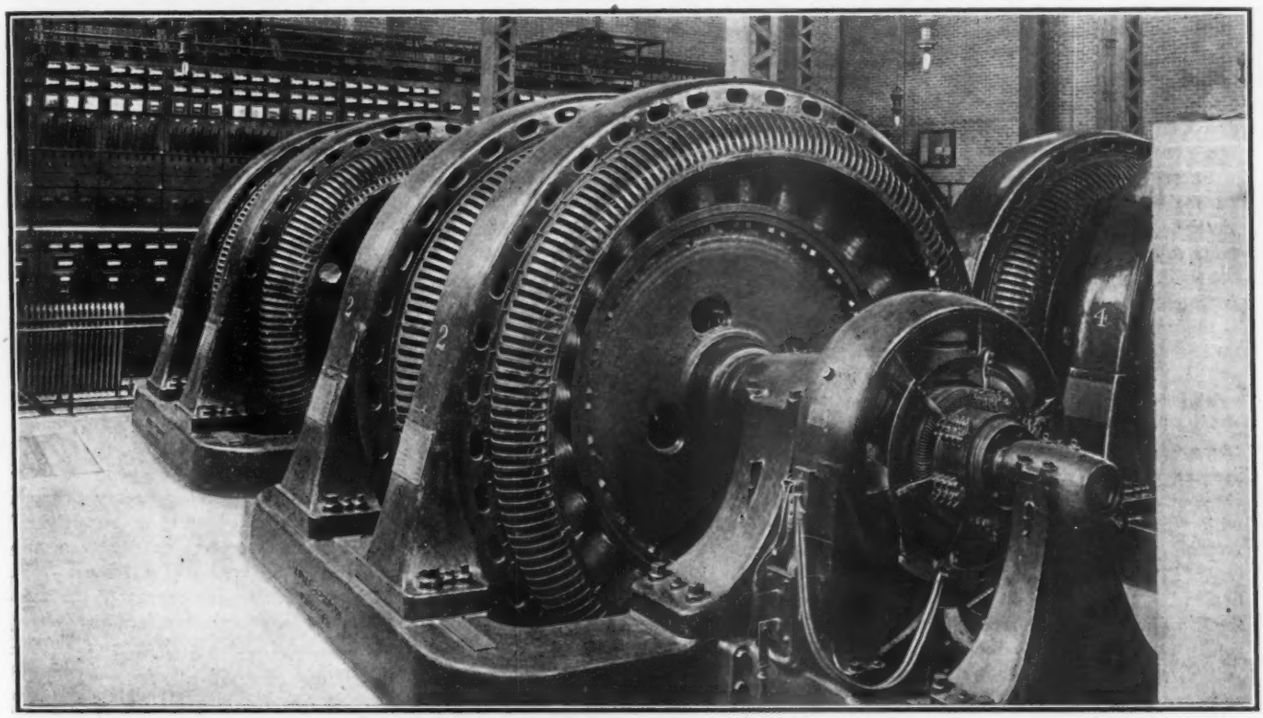


Fig. 20—60-25 Cycle Frequency Changer Set, Substation No. 5.

The 250-500-volt network receives energy through 12 feeders having a total cross-section of 8,500,000 circ. mils on each side. Substation No. 3 is provided with a tie-line of 2,000,000 circ. mils connecting its 230-volt buses with the 230-volt buses at substation No. 4, in addition to the two tie-lines previously mentioned connecting it with substations Nos. 1 and 2.

The series arc-lighting apparatus is operated on an all-night schedule of approximately 4100 hours per year, and supplies energy to 1850 series direct-current lamps, of which 1182 are the 6.8-amp enclosed-carbon type, 450 are of the 6.8-amp magnetite type, and 218 are of the 4-amp magnetite type. All of the enclosed-carbon lamps will be replaced by 6.8-amp magnetite lamps prior to Sept. 1 of this year. All arc circuits leave the station underground, use being made of 12-conductor cable in bringing the overhead arc circuits from the limits of the underground district to the station.

A unique feature of the arc-lighting equipment which has attracted the interest of electrical visitors for several years is a Leyden-jar discharger for removing static potential from the underground arc circuits. After various schemes were tried,

this device was adopted with satisfactory results. It consists, generally, of a rotating contact arm connecting a set of condensers alternately with the sides of the circuits and to ground.

The substation just described is unusual in that it controls the supply of energy to two separate direct-current three-wire systems, one of double the voltage of the other.

The upper floor of the substation No. 3 building is occupied by the meter department, electrical shop and a branch of the stores department.

Substation No. 4, located at Twentieth and Locust Streets, is a direct-current regenerating station, as well as a distribution point for 60-cycle energy. It contains two 1050-kw National motor-generator sets and one 525-kw three-unit motor-generator set, all similar to those already described. The scheme of connections for instruments, switches, etc., is similar to those at substations Nos. 1, 2 and 3, following the standard which has been established for all stations of the company.

The incoming transmission is effected over three No. 4-0, 6600-volt, 25-cycle, three-conductor cables and two No. 4-0, 4000-volt, 60-cycle, three-conductor cables.

The station supplies energy to the Edison network through 11 230-volt feeders totaling 16,000,000 circ. mils in cross-section. Sixty-cycle energy is furnished to the alternating-current distribution system over five No. 0 four-conductor cables, each phase being equipped with a voltmeter compensated for line drop, an ammeter, a watt-hour meter, automatic oil switch and a Stillwell regulator.

Substation No. 5 is located in a building erected on the rear of the lot occupied by the Union company's electric vehicle garage, on Morgan Street near Vandeventer Avenue. It contains four 1050-kw National frequency-changer sets, converting 6600-volt, 25-cycle energy into 2300-4000 volt, three-phase energy for the 60-cycle distribution system. On the shaft of each set is mounted a 50-kw, 125-volt exciter. There is also a 525-kw, three-unit set, comprising a 6600-volt, 25-cycle synchronous motor driving a 300-kw, 500-volt generator and a 200-kw, 125-volt generator; the 300-kw machine feeding energy into the 500-volt network and the 200-kw machine supplying charging energy to the company's garage and energy for starting the frequency changers. In addition, there is a 300-kw, 60-cycle, three-phase, 500-volt Westinghouse rotary converter which, with the 300-kw motor-driven generator, serves to uphold the voltage on the 500-volt network in the western section of the city. For charging vehicle batteries in the garage when the demand is not otherwise sufficient to require the operation of the 300-kw machine, there has been provided an equipment consisting of two 15-kw motor-generator sets, comprising 125-volt direct-current generators driven by Wagner 230-volt, 60-cycle, single-phase motors.

The substation receives its energy from the Ashley Street station over eight No. 4-0, three-conductor cables, four of which are at all times employed for 60-cycle distribution; the other four are arranged for use on either 60-cycle or 25-cycle systems, and are provided with suitable interlocking means to prevent connecting the two systems together.

The 60-cycle distribution board is provided with duplicate buses, each sectionalized at the center through non-automatic oil switches, thus giving virtually four buses for convenience in doing construction work or making repairs, and permitting the use of small range regulators. Each outgoing 60-cycle feeder has a hand-operated Stillwell regulator, a voltmeter compensated for line drop, an ammeter, a watt-hour meter and a hand-operated automatic selector oil switch in each phase lead. There are 13 of the 4000-volt, three-phase, 60-cycle, No. 0 four-conductor feeders, and provision has been made on the switchboard for five additional feeders. The supply of energy to the 500-volt system is through five No. 4-0 feeders, each equipped with ammeter and knife switches.

Incoming lines from Ashley Street are controlled by General Electric motor-driven oil switches. Outgoing feeders are controlled by General Electric single-pole selector oil switches, mechanically interlocked.

Substation No. 6, which is located in the engine-room of the Ashley Street generating station, is used chiefly as a distribution center for a portion of the 60-cycle output of both the Ashley Street and Lewis Street stations. It is also equipped with a 300-kw, 500-volt generator driven by a 6600-volt, 25-cycle synchronous motor.

The switchboard is a three-story structure, with its several floors communicating with the galleries of the Ashley Street station switchboard. The duplicate 60-cycle buses are at the top of the switchboard, and are arranged in a massive brick structure on which are also mounted the oil switches, disconnecting switches, selector switches and the shunt instrument transformers for the 60-cycle tie-lines to substation No. 5 and the tie-lines to Lewis Street. The second floor is occupied by the distribution buses, the automatic induction regulators and the automatic solenoid-operated remotely controlled feeder switches. The ground, or engine-room floor, contains the distribution feeder panels, with all instruments and control apparatus.

The 500-volt bus is tied to that at Lewis Street through a 1,000,000-circ. mil cable, and feeds energy into the 500-volt network through four No. 4-0 two-conductor cables. There are five outgoing 60-cycle, 230-volt, three-phase feeders, four of No. 0 cable and one of No. 4-0 cable. The switchboard provides space, however, for seven such feeders, each phase lead being equipped with an automatic induction-type regulator controlled by a contact-making voltmeter which is compensated for line drop, an ammeter, an indicating voltmeter, a watt-hour meter and a remotely controlled automatic oil switch. The 60-cycle busbars of this station are connected to the 60-cycle busbars at the Lewis Street station through four No. 4-0 three-conductor cables equipped with automatic remotely controlled oil switches at either end.

Substation No. 7 is a small obsolete 500-volt distribution center at 715 St. Charles Street, formerly used by one of the companies purchased by the Union company, as its point of supply to a 240-480-volt, three-wire, direct-current system. It is located directly over the railroad-tunnel approach to the Eads Bridge, to which tunnel it furnishes ventilation by means of a large motor-driven exhaust fan.

The substation proper contains three 300-kw, 60-cycle, 500-volt Westinghouse rotary converters receiving energy through Moloney transformers. There is also a battery of 280 cells of chloride accumulators. The station receives energy from the Lewis Street plant over three No. 0, three-conductor, 4000-volt, 60-cycle cables and, when operated, supplies energy to the 500-volt network through 11 No. 4-0 two-conductor feeders.

Incoming feeders enter all substations underground. Tie-lines of ample size are provided between the various substations. These are useful on occasions when trouble exists in any substation, and at times of light load permit the load of the smaller substations being carried on the most centrally located station, thereby effecting a considerable saving in operating labor. Duplicate telephone systems connect all operators with each other, with Ashley Street and with the general office.

All distribution feeders, both alternating current and direct current, are numbered by means of a co-ordinate system of notation which takes into account the street location at which the feeder terminates; thus, feeder N-1805 is at once known to end at the intersection of Eighteenth Street with the fifth street north of Market Street, the latter being the thoroughfare dividing the city north and south in the scheme of house numbering.

In addition to the Union substations just enumerated, the Ashley Street station supplies large quantities of 6600-volt, 25-cycle, three-phase energy to the Locust Street, South Broadway, Spring Avenue, Delmar Avenue, and, on occasions, to other and more remotely located rotary-converter substations of the United Railways Company of St. Louis. These transmissions are also by means of underground lines, the cables being of the same size and character as those supplying energy to the Union company's substations.

UNDERGROUND CONSTRUCTION.

By the terms of the Keyes ordinance, which was passed in 1896, all electric wires, except the street railway and certain signal, telegraph and telephone distribution wires, within the downtown district, bounded by the Mississippi River, Wash Street, Twenty-second Street and Poplar and Spruce Streets, have been required to be placed underground. This ordinance also directed that companies operating light and power lines should occupy joint conduits designated as "high-tension subways," and should be confined to one side of the street, while the telephone and telegraph companies should occupy similar low-tension subways on the other side.

Within the district established by the Keyes ordinance, joint high-tension subways were built by the several companies then doing business in that part of the city, the work being let to a contractor under specifications and subject to the supervision of a conduit committee composed of representatives appointed by the interested companies. Practically all of this joint subway has since come into the possession of the Union company through various consolidations and purchases. The joint subway owned by the Union company comprises about 1,747,000 duct-ft. In addition to its share of the joint subway, the Union company owns a large amount of conduit in the Keyes district, which it has constructed since the joint subway was installed, and it has also extended its underground district as indicated by the accompanying map, Fig. 21. In the dotted enclosure served by the Edison three-wire system all feeders and distribution wires are underground, this district extending several blocks west of the legal requirements. In the outer shaded section on the map all alternating-current feeders have been placed underground, distribution being effected by pole lines in the alleys. In addition to the subway lines which the Union Electric Light & Power Company has acquired or constructed under its own rights, it owns a one-half interest in the National Subway Company of Missouri, a company having the right to construct subways in any part of the city and to rent duct space to others. This company has approximately 842,000 duct-ft. of conduit installed in various parts of the city. The underground plant of the Union company thus comprises about 4,500,000 duct-ft., of which about 2,000,000 duct-ft. is within the Keyes district.

The joint subway was constructed of cement-lined sheet-iron pipe laid in a mass of concrete surrounding the pipes. A small amount of the individually owned conduit was also of this type, but the greater part is multiple-duct tile construction laid in an envelope of concrete. A part of the subways of the Union company and the National Subway Company is constructed entirely of concrete, locally designated as "monolithic conduit," a form of underground construction which has been worked out by the Union company's electrical department during the last 3½ years. All new work is now being put in of this type.

As shown in Figs. 24, 25, 26 and 27, wooden-duct molds of U-shaped section and 16 ft. in length are set into position on accurately aligned supports in the bottom of the trench. Concrete of 1:3:5 mixture is then dumped into place around the molds, and struck off even with their tops by means of a straight-edge attached to a long handle. After the concrete has taken its initial set, which usually occurs in about three hours, the forms are withdrawn, leaving smooth, straight, continuous, open grooves, which form the duct passages. The ducts are thus open to daylight during construction for thorough and rapid inspection. Thin molded-concrete plates, or slabs, are then laid across the open ducts and the whole covered with concrete, making a homogeneous and continuous mass. As Fig. 24 shows, the construction is adaptable to any size of run or number of tiers for which ordinary duct can be used. For runs of less than eight ducts the monolithic construction requires less concrete than first-class multiple-tile construction; for larger runs the quantity is about the same. By introducing suitable molds branch junction boxes can be cast at any point without additional expense.. The engineers report that the monolithic duct construction costs approximately half that of multiple tile purchased at 3 cents per duct-foot, both taken exclusive of trenching, refilling and repaving, which is practically a constant in either case. The all-concrete conduit has also the important advantages of being a solid homogeneous construction, which does away with joints and voids; is self-

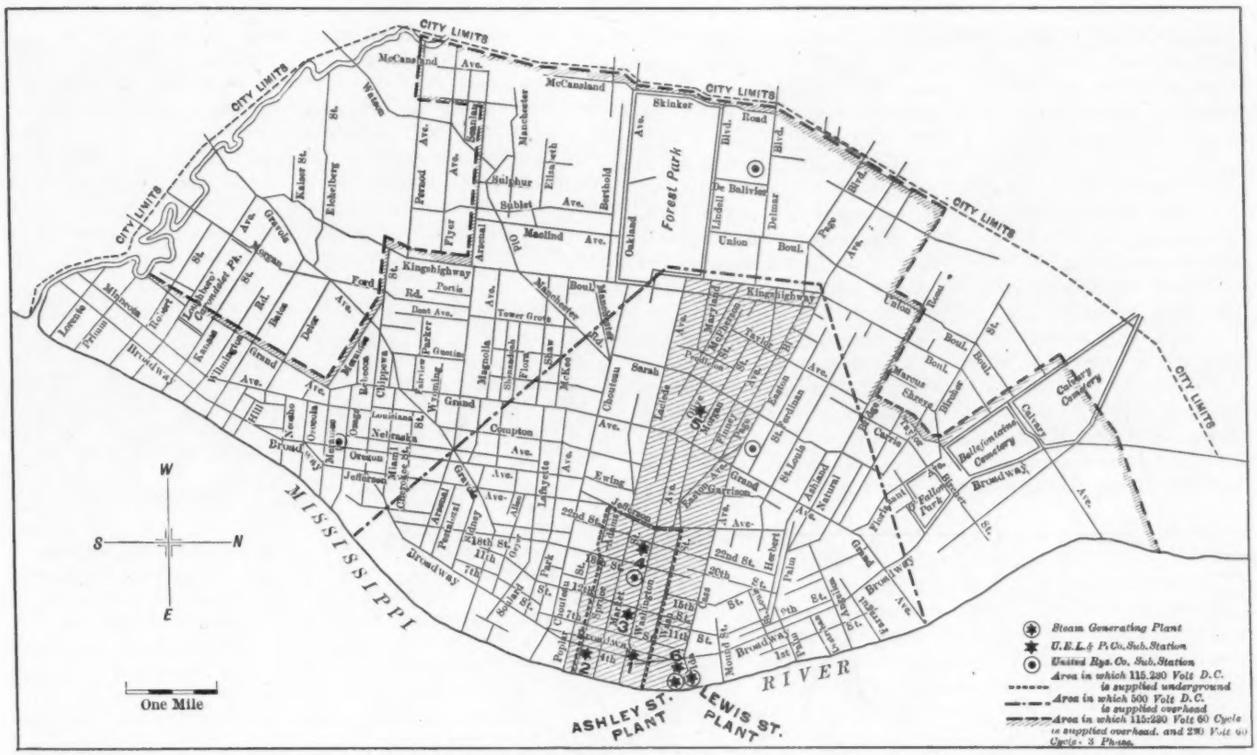

CITY LIMITS
Forest Park
MISSISSIPPI RIVER
ASHLEY ST. PLANT
LEWIS ST. PLANT
One Mile
Steam Generating Plant
U. E. L. & P. Co. Sub. Station
United Rys. Co. Sub. Station
Area in which 115-220 Volt D.C. is supplied underground
Area in which 500 Volt D.C. is supplied overhead
Area in which 115-220 Volt 60 Cycle is supplied overhead, and 220 Volt 60 Cycle, 3 Phase.

Fig. 21—Map of St. Louis.

aligned and of smooth bore; is open to inspection during construction, and affords adequate protection to cables even under conditions of severe electrical fires in the conduit.

In its underground system the Union company has about 500 manholes, at distances of a block apart. These are of both concrete and brick construction, and average 7 ft. x 7 ft. x 6.5 ft. in size. There are also about 2000 3-ft. x 3-ft. distributing handholes. Where the cables pass through the manholes they are fireproofed with a 0.5-in. coating of Portland

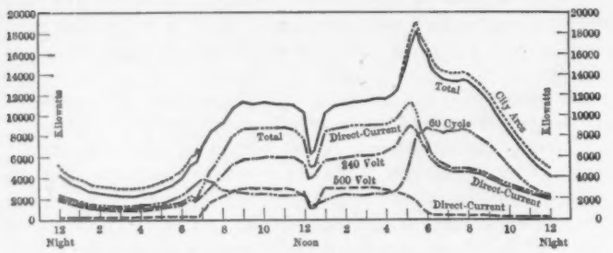


Fig. 22—Daily Consumption Curves.

cement mortar. This is retained in position like plaster on a lath wall by first wrapping the bare cable with ¼-in. Sisal rope, adjacent turns being wound 5/8 in. apart; the plastic cement is then wiped on with rubber gloves and finished with a quarter-round trowel.

The underground construction and repair department has two large motor-driven cable trucks, which are completely fitted up for their special work and are equipped with winches for drawing in the cable. One truck is arranged with a separate motor for driving the winch-head, while in the case of the other the winch is driven from the vehicle motors themselves, which can be disconnected from the wheels. With one of these trucks, a crew of six men and a foreman can draw-in from 3000 ft. to 5000 ft. of heavy cable per day. A cable reel is hauled behind the truck on the way to the work, the members of the crew and all the auxiliary apparatus, steel rope, sheaves, sheave skids, etc., being carried on the truck. The rodding of the ducts is now done with 16-ft. wooden slats, purchased at low cost from a sawmill, and put together with common

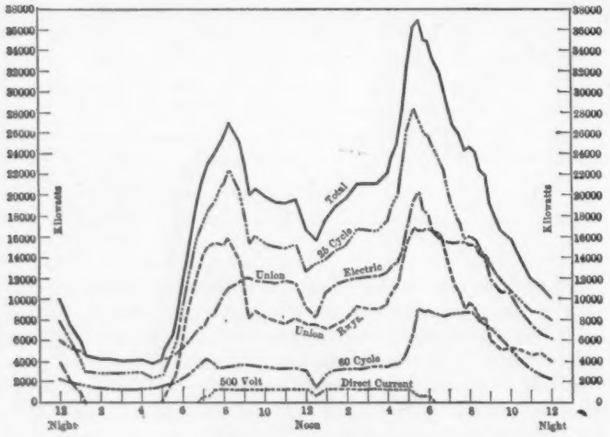


Fig. 23—Daily Load Curve.

baling wire. Such rods have the advantage of being much lighter than round jointed rods, and permit greater speed and less labor in rodding.

All low-tension feeders end in cast-iron junction boxes mounted on the walls of the manholes, the feeder cables being directly connected to the junction-box busbars. The main cables are connected to the busbars through copper catches designed to blow at several times the maximum rating of the cable. Main and feeder junction boxes are located at each street intersection, thus facilitating the sectionalizing of the cable mains and Edison tube. A comparatively small amount of Edison tubing is in use, and is supplied with energy through junction boxes mounted in manholes. The Edison tube mains are fused much more lightly than are the cable mains. Where the Edison tube fails, as is frequently the case, it is replaced with cable in a duct, use being frequently made of the monolithic conduit, as its construction lends itself particularly to this purpose on account of the ease and low cost with which services may be tapped off. All lateral cables or services are made with cable laid in iron pipe, the lateral cable being joined to the main cable in a service box or manhole with a lead-wiped joint. The total underground cable of all kinds constitutes a length of approximately 345 miles. At certain locations electrolytic conditions are rather severe, but damage to the lead sheaths of the cables is avoided by carefully bonding together all sheaths in all manholes, and attaching bonds to the rail where necessary. Electrolytic surveys are made at intervals of from three to four months to keep close check on the conditions prevailing.

OVERHEAD LINES.

In St. Louis the joint use of poles by all wire-using companies is very common, and is, in fact, the general rule. This condition arises from the fact that there are two telephone companies in the field who do not exchange pole space with each other, and from the city's restrictions relative to erecting more than one line of poles on either side of a street or alley. As the telephone companies are usually the first in the field and occupy the top cross-arms on their own poles, the lighting company is compelled to occupy the undesirable lower gains. Pole space is rented and exchanged at the rate of 60

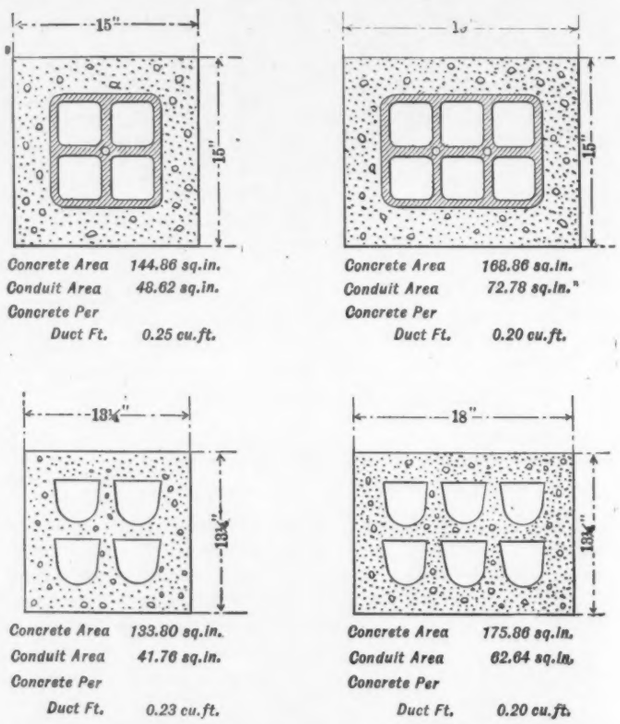


Fig. 24—Section of Monolithic and Equivalent Tile Conduits.

cents per cross-arm per year. Of the 30,000 poles carrying its lines, the Union company owns about 14,000.

Certain unusual and improved methods of construction distinguish the overhead lines of the Union Electric Company. Poles are shaved, gained, bored, framed and painted in the pole yard; cross-arms are oiled, seasoned, painted, pinned and braced in the storeroom—all with a view of avoiding field work as far as possible. Pole settings are made to a standard

depth, filled with excavated material to within 20 in. of the surface, thoroughly tamped and left until completely settled. Concrete is then poured around the pole, thereby forming a cylindrical collar 20 in. deep and 4 in. thick, with a 4-in. "wash" above the ground level. This concrete collar protects the pole from decay, besides increasing its apparent section and, consequently, the firmness with which it is held in the ground.

A metal clamp for making all attachments to cross-arms, the invention of Mr. S. B. Way, electrical superintendent, has been exclusively employed in the Union company's overhead construction during the past year. By the use of this clamp, applied to an insulator pin, the reduction in the useful section of the ordinary cross-arm due to the large holes is avoided, while instead of producing a splitting action tending to destroy the arm, the clamp encompasses the wood, thus increasing the ability of the cross-arm to withstand any torsional strains produced by the line attached to the pin. The use of the Way clamp eliminates troubles due to pins pulling out of cross-arms and greatly facilitates the removal of cross-arms without loosening the tie-wires. The device is also useful in strengthening split or checked cross-arms, which would otherwise have to be changed. The clamp now used in all of the

Fig. 25—Forms in Position for Laying Monolithic Conduit.

Fig. 26—Finished Duct, Grooves Open for Inspection.

Fig. 27—Cementing of Slab Covers—Completed Conduit.

company's construction work is supplied in several different sizes and types, for spreaders, pins, brackets, braces, dead-ends, sectionalizing, etc. The clamp element is in shape that of the cross-arm section, being split at the diagonal corners and drawn tight by bolts, which cause it to seat itself squarely on the wood on all four sides. When the clamp is applied to pins, the pin, if of the threaded type, is specially arranged to prevent insulator breakage due to extremes of heat and cold. While the cost of this metal pin, as well as any other metal pin, is, of course, greater than that of a wooden pin, the Union company officials believe that in the long run a great saving will be effected by the use of these clamp devices. The full strength of the cross-arm section is developed; there is no splitting action tending to destroy the arm, but, on the contrary, the use of the clamp binds and strengthens the wood; the attachments to the arm, being of malleable iron, neither break nor rot; the heavy labor charges in constructing, repairing and maintaining the pins, arms, poles and wires are greatly reduced, and the danger of accident or failure of service is very greatly diminished, with a consequent lessening of the charges to the injuries and damage account. Several accompanying illustrations show the clamp pins in use, and also the method of making a service connection by the use of clamp spreaders, carrying the wires across the back of the arm and pole. Braces are also arranged to be fastened to the cross-arms by a clevis cast integral with the pin clamp.

The joint use of poles in the city of St. Louis has emphasized the necessity of precautions on the part of the lighting company to protect all men having occasion to climb poles and to protect its own apparatus as far as possible against carelessness on the part of such men. As the four-wire, 60-cycle distribution system is operated at a pressure of 2300 volts between each phase wire and the grounded neutral, there is at all times great danger to lines from accidental contact between either phase wire and a grounded object. To minimize such accidental contact, the Union company has adopted a standard minimum spacing of 40 in. between pole pins, which allows ample room to climb a pole without coming in contact with primary circuits. The grounded neutral is invariably carried on one of the pole pins, thereby further lessening the danger of climbing the poles or working on the lines. In order to decrease the chances of interruption to service due to devices grounding out on the pole or cross-arm in wet weather all primary fuse blocks, switch boxes and demand-meter boxes are mounted on the cross-arms by means of special brackets and standard line insulators, thus relieving the strain on the insulation of the devices. Lightning arresters are not mounted on insulators for the reason that one side of the arrester is directly connected to ground. The line is, however, protected against failure of the arrester by a special cut-out of local origin which limits the current to ground through the arrester in case of failure of the arrester and at the same time leaves visual indication of trouble in the arrester for the benefit of the inspector. The cut-out, which is installed in the line side of the arrester connection, is so arranged that if shattered the connecting wires will fall in the clear. Demand indicators are used on all large individual transformer installations, as well as on all transformers connected to three-wire secondaries, and prove very useful in checking the maximum load on transformers, thereby permitting close selection of sizes. All neutrals of three-wire secondaries and the middle secondary connection on all transformers are grounded by means of plates buried in charcoal or coke with salt, or by means of a galvanized-iron pipe driven into the ground alongside of the pole. Connection between transformer or secondary neutral and the ground plate or pipe is made with heavy copper wire cleated to the pole and protected by wooden molding. The use of buck or right-angle arms is avoided, except for bringing primary connections down to a large transformer mounted on the pole; in such cases the wires are never brought within 3.5 ft. of the pole. Secondary circuits from large transformers are carried up the pole with lead-covered cable cleated to the pole. Service connections are never made from line pins or buck arms.

City restrictions prevent the use of racks built on poles for carrying large transformers. To meet this condition, and at the same time cheapen the construction cost, the Union company has adopted three-phase, pole-type transformers in large sizes, which the manufacturers have only recently placed on the market at the instance of the Union company. These transformers range in size from 20 kw to 75 kw and are mounted on regular line poles in accordance with the company's

standard transformer practice. The three-phase transformers, while especially intended to supply energy to motors, are arranged so that lighting service at 115-230 volts may also be supplied from one phase, thereby saving the installation of an additional lighting transformer in many cases. There are at present over 2400 transformers, ranging in size from 1 kw to 100 kw, installed on the company's lines.

All primary lines are placed on cross-arms with phases in standard order, and are invariably on separate arms from the secondary wires. All lines are securely guyed at ends, turns and corners, guy wires being made up with strain insulators. A scheme of cross-connecting and cut-out switches is in use and is being worked out for the entire alternating-current distributing system, whereby it will ultimately be possible to feed to any point over one of two lines in case of accident. The Union company has 3200 miles of overhead wire in service.

Fig. 29 shows one of the line-wagons used by the overhead line department of the company, in which the apparatus is arranged in the natural order of its use after arrival at the job. The ladders are carried on top and serve as a seat for the men. Places are also provided for the rubber goods, feed, torches, etc., while the glass insulators are carried in compartment trays in the box under the wagon body. Each wagon contains material for a full day's work, as well as tools for any job likely to be encountered, and the great number of articles to be carried are so arranged that no loss of time occurs on the work in hunting for material or tools. The company's stable and general storeroom occupy one building, making it very convenient to wash the wagons, check in unused or returned material and to supply material required for the next day's work. This arrangement permits much shorter hours for drivers and teams. The transportation facilities of the company are kept at a high state of efficiency, on the theory that it pays to reduce traveling or non-productive time to a minimum.

For stringing up or taking down long runs of wire, the

Fig. 28—Hauling in Cable With Winch Driven by Auto Truck Vehicle Motor.

wagons carry a 10-hp, 500-volt motor, which is belted and geared to a shaft on which can be mounted a winding drum for the pulling-in rope or a wire reel. The outfit can be placed in position ready for work within three minutes' time. While the actual running speed of the rope or wire is about the same as can be made by the use of the team, there is an actual gain in the amount of wire strung or taken down in a given time due to even speed, better control and doing away with the long ropes dragging in the street, besides the elimination of two men. The motor is energized from any convenient trolley wire or 500-volt main of the company.

The general foreman and his assistant in charge of the overhead department are provided with speedy automobiles to facilitate covering long distances, thus enabling them to keep in touch with their work.

In order to take care properly of all troubles and emergencies arising in connection with the distribution of its energy the Union company maintains a very complete trouble organization. This department is handled by three competent fore-

Fig. 29—Line Wagon of Overhead Construction Department.

men, each working eight hours, and having under them a corps of inspectors capable of taking care of any sort of trouble from a burning manhole or broken pole to a damaged socket or snap switch. The company renews customer's fuses or ascertains the cause of any trouble on customers' installations free, and in order to render quick and efficient service, provides automobiles for its inspectors.

To give its customers prompt and efficient service in repairing motors, fans or special apparatus the company maintains

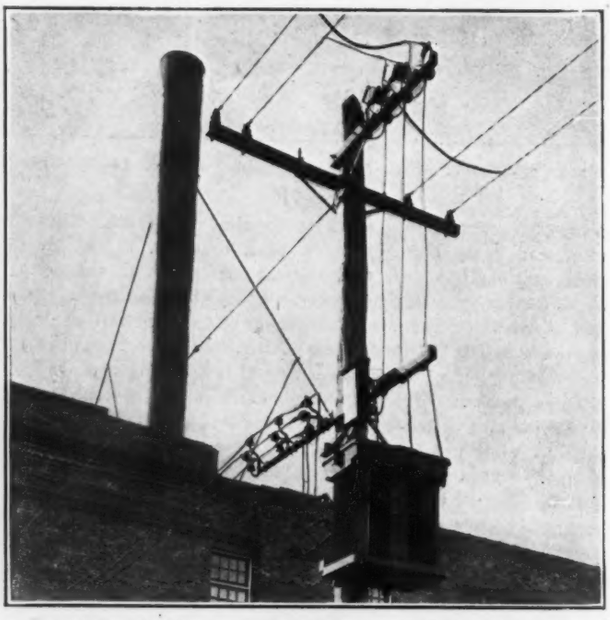


Fig. 30—Pole Mounting of Three-Phase Transformer, and Clamping Devices.

in connection with its switchboard, transformer and motor repair department men and facilities for undertaking any sort of electrical repairs, and keeps on hand a large stock of motors to loan to customers while their own motors are being repaired. To minimize customers' repair bills, this department maintains a free inspection service, by which a competent motor inspector calls at customers' installations at frequent intervals and leaves a written memorandum of the condition of the apparatus. All motor installations are tested soon after connection with a view of securing the best results for customers and to have data on file for reference in case the energy

consumption increases through a faulty drive or other cause.

METER AND LAMP DEPARTMENT.

The Union company officials believe in maintaining meters in the most accurate adjustment, and to this end maintain a well-equipped laboratory for the calibration and repair of all testing instruments. This laboratory is operated in connection with the meter department, which has charge of all watt-hour meters in stock and in service and the repair of these instruments. All service meters are tested in accordance with a schedule which is based on the character of the meter, its size and the class of service it measures. The frequency of regular periodic tests varies from 60 days in the case of large direct-current meters to one year in the case of small residence alternating - current meters. All meters are tested in place on the customers' premises; direct-current meters are tested by the ammeter-voltmeter method, using low-voltage storage battery or artificial load, while alternating-current meters are tested by comparison with rotating standards. As noted elsewhere, meters are read continuously every day in the month, making possible the use of specially qualified men continuously on that work.

Under the supervision of the laboratory samples from all packages of incandescent lamps are tested, thus maintaining the lamp quality at a high standard.

The head of the meter department also has charge of all arc-lamp and Nernst-lamp trimming and repairs; there are on the line of the Union company upward of 7000 arc lamps and 4500 Nernst lamps, all of which are owned and maintained by the company.

Mr. S. B. Way is chief engineer of the electrical department of the Union company. Mr. K. H. Hansen is assistant engineer. Under this direction has also been successfully carried out the difficult task of unifying into the needs of the present plant the varied generating, transmission and distribution equipment of the half-dozen formerly independent competing systems, comprising the Missouri-Edison plant with its 500-volt duplex circuit and 1150-volt, single-phase overhead and underground distribution; the Citizens' company with its system of underground conduit covering portions of the Keyes district; the Imperial company with its 235-470-volt, three-wire system covering the underground district; the Seckner Contracting Company's 6.8-amp series-arc circuits; the Carondelet Electric Company's 1100-volt, 125-cycle, single-phase system, and the Laclede Power Company having a 240-480-volt direct-current circuit, a 2300-volt three-phase circuit, and a 4000-volt three-phase circuit.

Mr. Alten S. Miller, President.

Mr. Hermann Spoehrer, Secretary and Treasurer.

Mr. John Hunter, Chief Engineer.

Mr. S. B. Way, Electrical Engineer.

Officers of Union Light & Power Co.

ADMINISTRATIVE AND BUSINESS METHODS OF THE UNION ELECTRIC LIGHT AND POWER COMPANY.

THE Union Electric Light & Power Company is incorporated under the laws of the State of Missouri. The directors of the company are: Messrs. Adolphus Busch, James Campbell, Samuel D. Capen, Horatio N. Davis, John H. Drabelle, Breckinridge Jones, Alten S. Miller, Henry Nicolaus, Festus J. Wade and Julius S. Walsh. The officers of the company are: President, Mr. Alten S. Miller; first vice-president, Mr. James Campbell, second vice-president, Mr. Breckinridge Jones; third vice-president, Mr. Festus J. Wade; secretary and treasurer, Mr. Hermann Spoehrer, and assistant secretary and treasurer, Mr. E. D. Pray.

ORGANIZATION.

The organization by which the business of the company is carried on comprises the several departments supervised by the secretary and treasurer, the chief engineer of power plants, the chief electrical engineer and the purchasing agent. The positions of president and general manager are combined in the person of the same officer, and to him report the heads having charge of the various departments. The general work relating to accounting, new business, contracts, advertising and the automobile department is under the supervision of the secretary and treasurer. The chief engineer of power plants, Mr. John Hunter, has charge of all the extensive physical equipment for the generation and application of steam power, besides the operation of a number of isolated heating plants and the general mechanical supervision of the buildings in which they are contained. The responsibility of the electrical engineer's department begins at the generators and includes all switchboard and auxiliary apparatus, substations, underground and overhead transmission and distribution plant, up to the service side of the customers' meters. This department, under the supervision of Mr. S. B. Way, embraces work usually carried out by several related divisions in other companies. The purchasing agent, Mr. E. H. Shufro, has charge of supplies and stores. The company has about 900 employees in its various departments.

FINANCIAL DATA.

Of the $18,000,000 authorized capital stock of the Union Electric Light & Power Company, $9,855,000 has been issued, in shares having a par value of $100 each. The company has a bonded indebtedness of $15,643,000.

The gross revenue for the year ended Dec. 31, 1909, was $3,085,614, from which were paid the operating expenses, taxes and reserves, amounting to $1,503,034, and the accrued interest of $834,204, leaving a net income of $748,376. In this year,

Fig. 31—Downtown Magnetite-Arc Street Lighting and Outlining of Electric Company's Building.

$593,100 was paid in dividends to the stockholders, at the rate of 6 per cent per annum on the capital stock, leaving a surplus for the year of $155,276. The total surplus is now $839,906.

For the preceding year of 1908 the total revenues from all sources were $3,013,297. Out of this were paid the charges for operating expenses, taxes, rent and depreciation, totaling $1,551,156, and $805,499 in interest due, leaving earnings of $656,642. After paying the annual dividend above named the surplus for 1908 amounted to $63,542.

OFFICES.

The offices and showroom of the Union Electric Light & Power Company occupy a four-story brick building, 60 ft. x 90 ft., at the corner of Tenth and St. Charles Streets. The first floor has been thrown into one large room, containing the lamp and electric appliance salesroom, cashiers' windows and contract department. On the second floor are part of the administrative offices, the bookkeeping and billing departments and the electrical engineer's department. On the third floor are the executive offices, the chief engineer of power plants' department, purchasing department, solicitors' room, automobile department and drafting rooms. The fourth floor is fitted up as a blueprint room. The basement is used for supplies.

The company's offices and stations are served by two private branch exchange telephone switchboards, the Bell has 49 and the Kinloch 27 local stations. Within the building, a pneumatic tube conveyor system connects the various floors and offices.

SALE OF ELECTRICAL ENERGY.

The total output of the Union Electric Light & Power Company's generating station during 1909 was 113,335,675 kw-hours. Of this amount 43,317,087 kw-hours was supplied to the United Railways Company of St. Louis, representing about 40 per cent of the energy required to operate its system of street railway lines. The railway company has an agreement with the electric company by which it obtains a maximum demand of 16,000 kw in 1910, 19,000 kw in 1911, 22,000 kw in 1912 and 25,000 kw in 1913. At the present time the requirements of the railway company constitute even a greater proportion of the total generation than is indicated by the 1910 figures. In January, 1910, for example, of the total 12,160,788 kw-hours generated, 5,195,300 kw-hours were taken by the railways, with a maximum demand of 17,375 kw. The terms of agreement for the sale of this energy impose a minimum load factor of 45 per cent and an approximation of successive daily load curves within 15 minutes of each other. Practically all of the energy is taken between the hours of 5 a. m. and midnight.

On Jan. 1, 1910, the Union Electric Light & Power Company had a total connected commercial load of 69,700 kw, made up of incandescent lamps, 38,310 kw; arc lamps, 3811 kw; Nernst lamps, 1423 kw, and motors, direct and alternating, 26,156 kw.

Fig. 32—Showroom at Union Electric Company Offices, St. Louis.

This total connected load is comprised of 34,677 kw on the 60-cycle lines, 23,688 kw on the 230-115-volt Edison three-wire direct-current service and 11,326 kw on the 500-volt direct-current system. The 26,156 kw in motors consists of 60-cycle alternating current, 5190 kw; 230-110-volt direct current, 9664

kw, and 500-volt direct current, 11,302 kw. The above load is supplied through 23,805 connections and is measured by 24,937 meters. Of the 18,000 alternating current connections included above, approximately 14,000 are in residences.

Among the large customers of the Union Electric Light & Power Company are the following, accompanied by the figures for their respective connected loads:

TABLE III.—LIST OF LARGE CUSTOMERS.

CUSTOMER	LOAD IN KW
St. Louis Car Company	2000
Century and Syndicate Trust Buildings	1200
Grand Leader, department store (auxiliary connection)	750
Forest Park Highlands (amusement park)	600
Third National Bank	400
Wood & Tiernan Co.	300
Coliseum	250
Jefferson Hotel	200
Butler Bros.	200

The King Electric Company and the Suburban Electric Light & Power Company purchase about 150,000 kw-hours each month, with a maximum demand of approximately 800 kw for resale among their customers in St. Louis County outside of the city limits. The Laclede Gas Company purchases about 500,000 kw-hours per month, with a maximum demand of approximately 2000 kw, for resale among its electrical customers in the city of St. Louis. The Union Electric Company supplies energy to practically every theater and newspaper plant in the city.

ISOLATED PLANTS.—STEAM HEATING.

The isolated plant situation in St. Louis is a difficult one for the central station to meet. With the great Illinois bituminous beds nearby, the small stations can purchase coal at as low as $1.85 per ton. Much of the slack from these mines, which will not bear freight charges to distant points, accordingly reaches the nearby market of St. Louis. It is thus not surprising to find 400 isolated plants within the local district. However, in spite of these difficulties, the Union Electric Company has been able to secure a good share of the isolated plant business, supplanting the generating outfits with central stations service and using the boilers already installed for low-pressure steam heating during the winter months. In several cases the company has even taken over the operation of complete isolated plants in city buildings, graduating their electrical output to the needs of the local steam-heating system in winter and shutting them down altogether during the summer time, meanwhile furnishing the marginal electrical service from the central station.

The principal wedge of entry into the local isolated plant situation has been the taking over of the summer loads of these stations by the electric company. As the owners of the plants are usually glad to shut down in the warm months when steam heating is not required, and since this additional load comes during the "off-peak" period of the central station year, the experiment, even if it goes no further, is usually a satisfactory one to both parties. But if, during this time, the isolated plant operator can be shown the advantages and economies of central station service—and he frequently can—a good customer for the year round is obtained.

In the following instances the Union Electric Company has supplanted isolated power plants with 12-month central station service, operating the former plant boilers with its own firemen on low-pressure steam-heating systems during the winter:

Woodward & Tiernan Printing Company, 1,500,000 cu. ft. This is a large printing establishment occupying a quarter block, which formerly contained a 250-kw isolated plant. Two of the three 150-hp boilers are now used for low-pressure heating.

Merchants-Laclede Bank Building, 1,500,000 cu. ft. This is an office building, which also supplies service to a store adjoining. It formerly contained a 100-kw plant, the two 150-hp boilers being now used for low-pressure heating.

Century and Syndicate Trust buildings; these were formerly served by a 300-kw isolated plant, but are now heated from the Tenth Street station.

In the following buildings the company has installed isolated steam-heating equipment which remains its own property:

Butler Brothers, 9,000,000 cu. ft. General wholesale merchandise establishment, occupying a full block. Three 300-hp boilers.

New Third National Bank Building, 1,900,000 cu. ft. Two 250-hp boilers.

Marquette Hotel, 1,700,000 cu. ft. The Union Electric Company assumes all mechanical and electrical supervision of this property. One 375-hp boiler.

Heat for the following buildings, totaling 16,000,000 cu. ft., is obtained from the exhaust steam of the Tenth Street generating station, all of the buildings being within a radius of 700 ft. of the boilers, the steam being carried vertically about 200 ft.: Century Building, Syndicate Trust Building, Union Electric Light & Power Company's offices, Kinlock Building, Board of Education Building, Wall Building, Lammert Furniture Company Building and several small stores.

The following two cases furnished rather exceptional instances, in which a central-station company is engaged in operating isolated-plant electrical generating properties in its own territory:

The Carleton Building power plant comprises two 125-hp O'Brien down-draft boilers, a 50-kw, 110-volt Westinghouse direct-current generator, driven by a simple Chuse engine, and a 50-kw machine of similar type driven by a Chuse compound engine. The building contains three hydraulic elevators, operated by steam-driven pumps. The expense of converting this machinery to motor drive is responsible for continuing the steam power equipment. All the energy developed is used within the walls of the building, for lamps and motors.

The Merchants-American National Bank Building, isolated plant, contains two 125-hp boilers, supplying steam to two Chuse engines, driving 110-volt General Electric direct-current generators, one unit being of 625-kw, and the other of 125-kw rating. As now operated, the two 125-volt generators are connected in series, and thus supply 250-volt energy to a 25-hp elevator motor, besides feeding to the company's Edison network. The larger machine is thus, of course, much underloaded, but this arrangement enables the electrical output of the generator to be conformed to the steam-heating needs of the building. The La Salle Building, in the same block, is also heated from this plant.

As the above examples show, after getting one isolated heating system under its operation, the central-station company is frequently able to go next door or within the same block and replace isolated electrical plants, supplying winter steam from the boilers of the new station, and electrical energy from its main generating plant.

The steam-heating business is on the increase, and the St. Louis central-station company is also undertaking, as adjunct to this work, the complete expert mechanical supervision of the buildings in which it replaces isolated plants.

ELECTRIC VEHICLES.—COMPANY GARAGE.

Three years ago the number of electric automobiles in use in St. Louis was far behind the proportion observed in other cities with similar advantages of well-paved streets. At that time there was in the city only one agency for battery-propelled vehicles, and such machines as were in service had proven unsatisfactory, owing to the inadequate and inexpert attention given their cells in private garages. Recognizing the value of the automobile-charging demand as a desirable load, the Union Company built and undertook, as a central-station proposition, the operation of a completely equipped garage for electric vehicles, expending some $50,000 in the site and structure on Morgan Street, near Vandeventer. Although there were at that time only about 34 vehicles and trucks in the entire city, the garage was designed with space for 80 machines, while provision was made for charging 64 vehicles simultaneously and independently, without series connection. It is of some interest to note that during the first year the garage was open an amount of money was spent in advertising which probably equalled the total investment in the 18 electric pleasure automobiles in St. Louis at that time.

The result of the local impetus which the Union Electric Company garage has given the battery-propelled vehicle by proving the latter's entire satisfaction when properly attended, is shown by the present number of 375 electric cars and trucks in use in St. Louis. There are now nine agents, selling twelve different makes of electric vehicles. Besides four additional public battery-charging stations, since opened up, the present number of 46 private garages, equipped with mercury rectifiers, in the alternating-current residence section, is also increasing rapidly. These latter private garages are supplied with energy at the motor-service rate on a separate meter, when desired.

At its Morgan Street garage, the Union Company receives $35 per month for each vehicle, including charging of cells, inspection and calling for and delivering machines. About 70 automobiles are now quartered there, and 17 men are employed about the place. The company also acts as sales agent for two makes of electric vehicles, both trucks and pleasure cars.

The success of the Morgan Street garage, which is now becoming taxed for space, has caused plans to be prepared for another in the downtown district, intended especially for commercial vehicles. The former power-station building of the Missouri Edison Company, at Twentieth and Locust, now occupied in part by substation No. 4, will be fitted up with charging and storing facilities for 150 trucks, while the present Morgan Street garage, which is located in the residence section, will then probably be occupied by pleasure vehicles exclusively. A night view of this garage is shown in Fig. 33.

Mr. C. E. Michel has charge of the electric-automobile garage and the sale of electric vehicles for the company.

NEW BUSINESS GETTING.

A force of new-business solicitors is maintained by the contract department of the company. The work of these men has become somewhat specialized, some devoting their time to securing lighting business, and some to the motor-application field. An exhaustive campaign is now being planned, taking up in order various trades and businesses and making a study of the requirements and particular advantages of electric service for each. The solicitors meet in a conference with the head of the department each morning, to receive instructions and suggestions for the day's work, and are required to make reports of calls made.

Literature urging the installation of electric wiring is sent to all persons obtaining building permits, this circular matter being reinforced by a call from the solicitor who suggests to the property owner various arrangements for obtaining electrical conveniences. Architects are also prevailed upon to specify the installation of base-board receptacles for connection to heating devices.

The company does no wiring, leaving this entirely in the hands of the local contractors, with certain exception. For $15 the company will install with open wiring a special fixture containing four 60-watt tungsten lamps. If desired, payment may be made in 12 monthly installments of $1.25 each, added to the lighting bills. In outlying sections of the city where no direct-current is available for operating the arc lamps in moving-picture machines, the company stands ready to install a mercury-rectifier set, providing the customer guarantees a minimum bill of $50 per month for the energy consumed. Further plans are now being formulated for assisting in the sale of electricity by financing such installations. An excellent field for this, for example, is the refrigeration of meat markets. Such demands make an excellent motor-load for the central station, but usually the butcher and small tradesman has not enough capital to invest in the first cost of these refrigerating machines. The new financing proposition is accordingly devised to extend payment of this cost over a period such that the consumer can conveniently meet the expense of the installation.

ELECTRIC HEATING APPLIANCES.

In its handsomely appointed new showrooms in the office building at Tenth and St. Charles streets, the Union Electric Light and Power Company maintains a complete exhibit of domestic and heating appliances, selling this class of apparatus at the list prices given in the manufacturers' catalogs. The sale is either made outright, or effected along terms more convenient to the customer when desired. Thus a 500-watt flat-iron, which is listed at $6, will be loaned for 30 days' free trial on payment of $2 down, and the agreement to make two subsequent monthly payments of $2 each, if accepted. These irons are maintained in repair, free of charge, the company replacing cords or heating elements that become broken or burned out. The advantage of keeping these energy-consuming devices in service, it is thought, justifies the expense of renewing deficient parts. Newspaper advertisements appear from time to time, reminding customers to bring faulty irons in for free repairs.

Fig. 33—Union Electric Company's Electric Automobile Garage and Salesroom.

Besides flat-irons, the Union Company has had good success in selling other electric heating appliances, such as toasters, curling irons, heating pads and disk stoves, the latter especially in the 4.5-in. and 6-in. sizes. Several solicitors are employed, two of them women, who devote their time to the introduction of this class of apparatus in residences, etc. Sometimes these solicitors are put on a house-to-house campaign, canvassing every residence in a certain district, while on other days they call on "new connections"—houses in which electric service has recently been installed. These visits are carefully timed to occur after the second monthly bill has been received, as it usually happens that following the free use of light and the

consequent large bill for the first 30 days, the second month is a period of the extremest lighting economy. When the resulting bill comes in, the housewife is usually well pleased and in a satisfactory mood to talk of electrical conveniences. The heating-appliance solicitors also take orders for other devices, including sewing-machine motors.

ELECTRIC SIGNS.

St. Louis has admittedly been backward in the use of electric signs, although this is probably accounted for by a city ordinance, which prohibits the installation of any signs projecting more than 18 in. beyond the property line. The former indefinite status of this ordinance, which it was felt might be questioned or repealed at any time, prevented merchants and advertisers from planning heavy investments for comparatively small advertising returns, while the possibility of erecting

Fig. 34—Spectacular Electric Sign, Corner Broadway and Market Street.

larger displays remained. With no immediate relief in sight, the advertisers have now philosophically concluded that they can get up quite attractive building and roof signs within the limits of the law, and the electric-sign business is now progressing rapidly. At the present time in St. Louis there are about 200 electric signs, containing 40,000 lamps. Besides the Union Electric Company's attractive "emery-wheel" sign, mentioned elsewhere, other large spectacular signs are coming into use, one containing 2000 lamps, on the roof of the building at Broadway and Market Street, being illustrated in Fig. 34.

RATES FOR ENERGY.

Electrical energy is sold in St. Louis under a rate schedule which recognizes five classes of service, namely, commercial lighting, commercial motor service, residence lighting, non-contract rate (lamps and motors), church, hospital and eleemosynary-institution lighting.

Under the commercial lighting schedule a fixed rate of from 12 to 8 cents per kw-hour is offered, depending on the minimum monthly hours' burning which the customer is willing to guarantee, and upon the number of 16-cp. equivalents connected. This rate begins at 12 cents per kw-hour for a connected service of less than 100 lamps, on which 10 cents per month each is guaranteed; diminishing, as shown in Fig. 35, by quarter-cent steps down to an even five cents per kw-hour for very large services on which a large minimum guarantee is made. The minimum monthly guarantee under the commercial lighting rate is $1 per month.

The standard "power" or motor-service rate implies a minimum monthly guarantee of $1.50, at which figure the consumer pays 11 cents per kw-hour for all connected loads under 10 hp of motors. As shown by Fig. 36 connections and for larger minimum guarantees per horsepower connected, this rate also diminishes by short intervals to 4.5 cents per kw-hour for loads above 10-hp, on which a minimum of $7.50 per hp is assured; or loads over 500 hp on which a $2 minimum is assured, or their equivalents in intermediate loads and guarantees.

By the two preceding schedules, which are clearly tabulated and explained in a booklet issued by the company, the customer is enabled to select his own rate—from 12 cents to 5 cents per kw-hour for lighting, and from 11 cents to 4.5 cents per kw-hour for motor service—depending on the guarantee of minimum consumption per unit of demand, which he is

CONNECTED LOAD IN EQUIVALENT 16 C. P. LAMPS	MINIMUM MONTHLY GUARANTEE FOR EQUIVALENT 16 C. P. LAMP CONNECTED, IN CENTS.																			
	10	15	20	25	30	35	40	42½	45	47½	50	52½	55	57½	60	62½	65			
UNDER 100	12	11½	11½	11½	11	10⅝	10½	10⅛	10	9⅝	9½	9¼	9	8⅝	8½	8¼	8			
From 100 to 150	11½	11½	11½	11	10⅝	10⅛	10⅛	10	9⅝	9½	9¼	9	8⅝	8½	8¼	8	7¾			
" 150 " 200	11½	11¼	11	10⅝	10⅛	10⅛	10	9¾	9½	9¼	9	8⅝	8½	8¼	8	7¾	7½			
" 200 " 250	11¼	11	10⅝	10⅛	10⅛	10	9¾	9½	9¼	9	8⅝	8½	8¼	8	7¾	7½	7¼			
" 250 " 300	11	10⅝	10⅛	10⅛	10	9¾	9½	9¼	9	8⅝	8½	8¼	8	7¾	7½	7¼	7			
" 300 " 350	10⅝	10⅛	10⅛	10	9¾	9½	9¼	9	8⅝	8½	8¼	8	7¾	7½	7¼	7	6¾			
" 350 " 400	10⅛	10⅛	10	9¾	9½	9¼	9	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½			
" 400 " 450	10⅛	10	9¾	9½	9¼	9	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼			
" 450 " 500	10	9¾	9½	9¼	9	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6			
" 500 " 550	9¾	9½	9¼	9	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9			
" 550 " 600	9½	9¼	9	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8			
" 600 " 650	9¼	9	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7			
" 650 " 700	9	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6			
" 700 " 800	8¾	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5			
" 800 " 900	8½	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5				
" 900 " 1000	8¼	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4				
" 1000 " 1250	8	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4					
" 1250 " 1500	7¾	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3					
" 1500 " 1750	7½	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3						
" 1750 " 2000	7¼	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.2						
" 2000 " 2250	7	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.2							
" 2250 " 2500	6¾	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.2	5.1							
" 2500 " 2750	6½	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.2	5.1		RATES IN CENTS PER KILOWATT HOUR.						
" 2750 " 3000	6¼	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.2	5.1	5								
3000 & Over	6	5.9	5.8	5.7	5.6	5.5	5.4	5.3	5.2	5.1	5									

Fig. 35—Schedule of Standard Lighting Rates.

willing to make. The above methods of charging may at first appear complex, but little difficulty is experienced in convincing the customer of the equitability of these rates, after having worked out with him some example or the figures for his own case, in accordance with the tables furnished.

Bills under both of the preceding rates are further subject to "hours' use" and "quantity discounts." Thus for one hour's

CONNECTED LOAD IN RATED H.P.	MINIMUM MONTHLY GUARANTEE PER HP. CONNECTED																			
	$1.00	1.15	1.30	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50			
1 H. P. and under								7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5			
Over 1 to 3 H. P. inc.				10¢	9	8	7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8			
" 3 to 5 H. P. "			10¢	9	8	7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.6			
" 5 to 10 H. P. "		10¢	9	8	7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5			
" 10 to 20 H. P. "	10¢	9	8	7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5				
" 20 to 30 H. P. "	9	8	7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5					
" 30 to 45 H. P. "	8	7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.6	4.5						
" 45 to 60 H. P. "	7½	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5							
" 60 to 75 H. P. "	7	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5								
" 75 to 100 H. P. "	6¾	6½	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5									
" 100 to 125 H. P. "	6½	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5										
" 125 to 150 H. P. "	6¼	6	5¾	5½	5¼	5	4.8	4.8	4.5											
" 150 to 200 H. P. "	6	5¾	5½	5¼	5	4.8	4.8	4.5												
" 200 to 500 H. P. "	5¾	5½	5¼	5	4.8	4.8	4.5													
Over 500 H. P.	5½	5¼	5	4.8	4.8	4.5														

RATES IN CENTS PER KILOWATT HOUR.

Fig. 36—Schedule of Standard Motor-Service Rates.

use, daily, of the maximum connected load, a discount of 6 per cent is made, rising to 25 per cent for all over 18 hours' daily use of the maximum. Bills under $10 are subject to 5 per cent discount if paid within 10 days of their date; bills of $100, 20 per cent; $1,000, 40 per cent; $9,000, 56 per cent, etc.

With the above discounts, these schedules work out for several typical businesses at about the following equivalent rates per kw-hour, which are seen to be practically those prevailing in other cities of similar size. In fact, the average rate per kw-hour, at which electrical energy is sold for all classes of service in St. Louis, is 5.57 cents, which is slightly less than the similar average charges in Chicago and New York, reported to be 5.91 cents and 5.82 cents, respectively.

For example, a small clothing factory uses its 2-hp equipment in motors eight hours daily. If the customer guarantees $6.50 per hp per month, he obtains a base rate of 5.25 cents per kw-hour, subject to the hours' use and quantity discounts. The first discount, 21.5 per cent, applied to his monthly consumption of 360-kw hours, besides an additional 5.5 per cent discount for quantity used, makes his bill $14.01 per month, or a net rate of 3.89 cents per kw-hour.

A small billiard hall, which uses 50 16-cp lamps six hours daily, pays a net bill of $29.13 for 450 kw-hours, or at a net rate of 6.47 cents per kw-hour.

In a factory a 200-hp motor drive is operated four hours daily, consuming 18,000 kw-hours per month, for which $442.80 is charged after allowing the discounts on the most favorable guarantee schedule. The equivalent rate in this case is 2.46 cents per kw-hour.

An electric sign containing 416 2-cp lamps, which are used for six hours per day, is operated at a net monthly charge of $57.66 for the 936 kw-hours consumed, or at a rate equivalent to 6.16 cents per kw-hour.

If desired, small motors under 5 hp may be included in the lighting rate, when installed as part of a mixed lighting and motor installation and contracted for under the first schedule.

For strictly summer or off-peak business, a further discount is allowed of 20 per cent off the regular schedule for the commercial lighting and motor-service rates.

The residence rate involves a straight charge of 12 cents per kw-hour, with a minimum charge of $1 per month for ten 16-cp equivalents or less, and three cents for each additional lamp over ten. Bills paid within 10 days are subject to a quantity discount of a higher rate than that offered for commercial service, beginning at 5 per cent for $5.00 or under, and rising to 25 per cent for bills of $50 and over.

The consumer on the "non-contract" application purchases electrical energy at a straight rate of 12 cents per kw-hour, assuring a minimum bill of $1 per month and 50 cents per hp per month for his motor equipment. Any number of lamps may be connected up under this agreement. If the connection is made for less than one year, however, a special charge is made for connection and disconnection.

Churches, hospitals and eleemosynary institutions are given a rate of 12 cents per kw-hour, being required to assure a minimum of only five cents per 16-cp equivalent, instead of 10 cents, as in the commercial lighting schedule.

The company also offers a special flat rate of $15 for operating electric ceiling fans throughout the season, and will make a flat rate on electric signs which its employee turns on and off, this charge being based on the regular rate for six hours' burning each night.

LAMP SALES AND RENEWALS.

The company makes carbon-lamp renewals free of charge, after the customer has purchased outright his first supply of lamps to fill his connected sockets. When new tungsten lamps are desired in exchange for old carbon-filament lamps, allowance is made for the value of the latter, on a lamp-for-lamp basis. Tungsten-lamp sales and renewals are made according to the schedule shown in Table IV.

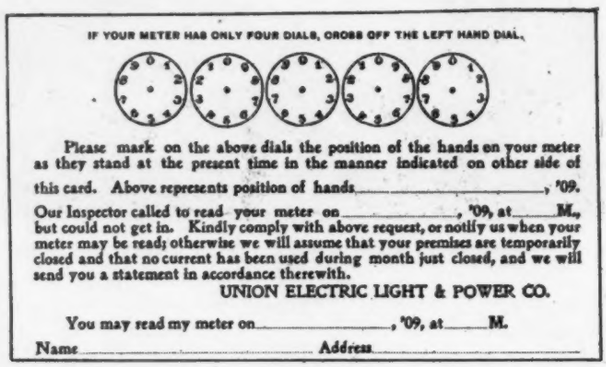
TABLE IV.—SCHEDULE OF LAMP PRICES.

Rating Watts	Clear Lamps		Frosted Lamps	
	Selling Price	Renewal Price	Selling Price	Renewal Price
25	$0.55	$0.40	$0.60	$0.45
40	0.60	0.45	0.65	0.50
60	0.75	0.60	0.85	0.70
100	1.10	0.80	1.20	0.90
150	1.40	1.00	1.50	1.10
250	2.40	1.50	2.00	1.60

The above sales and renewals may be made at the sales counter in the show room; or, on request, the company's delivery wagons will call at the consumer's house, delivering lamps for sale or renewal. Mr. W. R. Johnson is contract agent.

BILLING AND ACCOUNTING.

Meters are read and bills rendered every day in the month, thus avoiding the special pressure on the meter-readers and accounting force, which would otherwise occur at certain periods, as well as congestion in the payment of bills, due to the desirability on the part of the consumers of taking advantage of the discounts offered. To accomplish this even loading of the working staff, the city is divided into 24 districts, taken as the number of working days in the minimum month. The schedule card is then worked out in accordance with the following routine, the card indicating, for each department or section, the district to be handled that day. These cards are printed and copies are furnished to all concerned, so that there can be no conflict or misunderstanding of the order in which the districts receive attention. Following the schedule for a given consumer in one of these districts, it is found that on, say, the 15th of the month, his meter is scheduled to be read. The following day the readings are transferred. On the next, there is an opportunity for the reader to examine or reread meters, if necessary. On the third day the bills are sent out, dated the 19th. The next column of the table shows the last discount day (the 29th), and then at intervals of five days two notices are sent out. Following a disregard for these notices the customer is, after seven days, transferred to the delinquent list and disconnected, having received practically two months of unpaid service.


IF YOUR METER HAS ONLY FOUR DIALS, CROSS OFF THE LEFT HAND DIAL.

Please mark on the above dials the position of the hands on your meter as they stand at the present time in the manner indicated on other side of this card. Above represents position of hands_____, '09.

Our Inspector called to read your meter on_____, '09, at_____M., but could not get in. Kindly comply with above request, or notify us when your meter may be read; otherwise we will assume that your premises are temporarily closed and that no current has been used during month just closed, and we will send you a statement in accordance therewith.

UNION ELECTRIC LIGHT & POWER CO.

You may read my meter on_____, '09, at_____M.

Name_____ Address_____

Fig. 37—Return Addressed Post Card Left by Meter Reader for Absent Consumer.

When a meter reader makes a call and finds no one at home to allow him access to the meter, he leaves a stamped return-addressed post card of the kind reproduced in Fig. 37. This card explains that the inspector called for the purpose of reading the meter—giving the hour of his visit—and requests the householder either to mark on the blank dials reproduced on the card the positions of the hands of his meter register, adding the date, or to advise the company of some time when the inspector may call again. The legend also explains that if no answer is received, the company will assume that the premises are closed and that no energy has been used during the month, and will render its minimum bill accordingly. Besides the saving in the expense of sending back the inspector a second time to read the meter, it is noted that customers are usually well pleased with the privilege of reading their own meters, and mark their cards carefully. Although, of course, no technical knowledge of the meaning of the pointer positions is required, the customer can by comparing his corresponding bill with the indication he marked down learn the

significance of the various dial readings. In case of error or failure to report, the correction is caught at the next reading of the meter. Some difficulty was at first experienced with the consumers' forgetfulness to add their own names and addresses to the card after marking in the hands, so that the inspectors now give each card an identification number when they leave it.

A looseleaf ledger system is employed, made up of 8-in. x 12-in. cards, on which space covering four years' service is provided for a record of all items relating to the supply of service to the customer whose name appears on the first line. The character and amount of his connected load, monthly consumption, contract rate, etc., are all clearly shown on these cards, which can be taken to the counter for discussion with the customer if required. These ledger cards are filed in portable metal boxes, in the order of the inspectors' routes. For the convenience of the accounting force, special tables have been constructed, holding four of these 600-card boxes, two in front of each accountant. The cards are protected by a glass slide and, in their metal boxes, are removed to the vault at night.

The complaint department is located on the second floor, adjacent to the billing and accounting departments, thus allowing ready reference to all files and ledger records which pertain to the customer's service. In this way, also, customers having complaints to discuss are separated from others calling to pay bills and from applicants for new connection, who transact their business in the general offices on the first floor. Duplicate bills are also issued in these lower offices, which are connected by a pneumatic-tube carrier system with the accounting department above. The attractive display of household electric devices in the lower showroom thus gives the waiting customer something to examine and interest himself in while the duplicate bill is being made out.

All of the correspondence on any subject relating to each customer is assembled in file cases in this department, so that in taking up a given matter the company's representative may be sure he has at hand all of the customer's letters and expressed wishes. Mr. C. E. Brenton is auditor for the company.

ADVERTISING.

Modern methods of bringing its wares to the attention of the general public have been adopted by the Union Electric Light & Power Company. Such mediums as newspaper advertising, billboard signs, electric signs, house organs, carefully prepared printed matter, etc., are among the means used by the central-station company to interest prospective users of electrical energy.

A display advertisement is run each day in one of the local papers. Some of these have taken the form of talks on the relations between the company and its customers; others point out the advantages of electrical energy for lighting and for motor service. A feature of these advertisements has been the use of pen sketches surrounding the text matter, which is itself set forth in an unusual, bold-face type.

Excellent use of contrast is made in comparing the conditions prevailing in motor-driven and in isolated-plant operated shops. Thus, for example, the sketch at the left of one "ad" shows workmen idling about their machines, while in the engine-room below others are struggling with a hot bearing. Opposite this is a picture presenting the busy scene in a motor-driven shop, while the space of the former engine-room is now seen to be used for storage or other commercial purposes. Other advertisements depict the loss of time entailed by broken belts and engine failures; the dirt and smoke created by isolated plants; the economy of operating one department overtime without running the entire plant; the improved safety to employees and property when belts, shafting and boilers are eliminated, and the possibility of locating the motor-driven factory in the more desirable sections of the city, without regard to the presence of shafting. The reproductions of Union Electric advertisements given in Figs. 38 and 39 show the distinctive use made of display space.

A striking, spectacular sign, advertising central-station service for motor drive, erected on Broadway, near Morgan, is visible for twenty blocks down the main street. The sign, which is shown in Fig. 40, is 41 ft. high, 43 ft. long and contains 2000 lamps. It is bordered on three sides by the representation

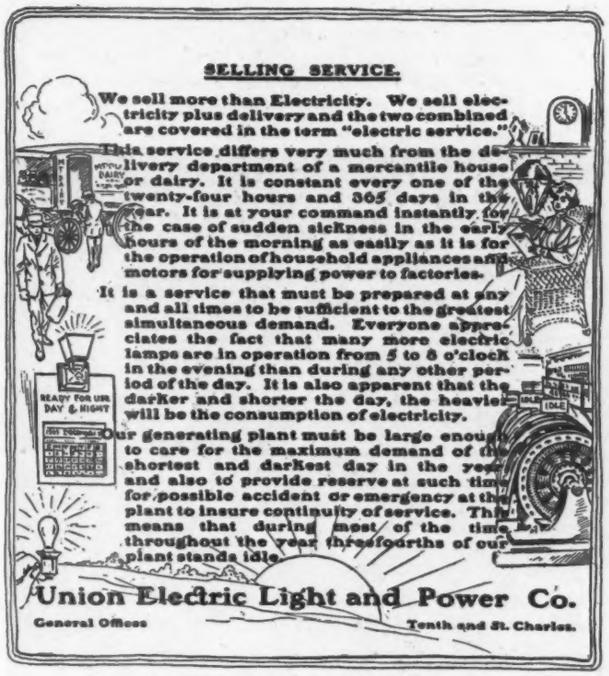

SELLING SERVICE.
We sell more than Electricity. We sell electricity plus delivery and the two combined are covered in the term "electric service."
This service differs very much from the delivery department of a mercantile house or dairy. It is constant every one of the twenty-four hours and 365 days in the year. It is at your command instantly for the case of sudden sickness in the early hours of the morning as easily as it is for the operation of household appliances and motors for supplying power to factories.
It is a service that must be prepared at any and all times to be sufficient to the greatest simultaneous demand. Everyone appreciates the fact that many more electric lamps are in operation from 5 to 8 o'clock in the evening than during any other period of the day. It is also apparent that the darker and shorter the day, the heavier will be the consumption of electricity.
Our generating plant must be large enough to care for the maximum demand of the shortest and darkest day in the year and also to provide reserve at such time for possible accident or emergency at the plant to insure continuity of service. This means that during most of the time, throughout the year, three-fourths of our plant stands idle.
Union Electric Light and Power Co.
General Offices
Tenth and St. Charles.

Fig. 38—A Union Electric Public Service Talk.

of a pole line terminating at a motor, all picked out in lamps. A belt from this motor is apparently in motion, driving an emery wheel, against which a metal bar is seen to be fed. The

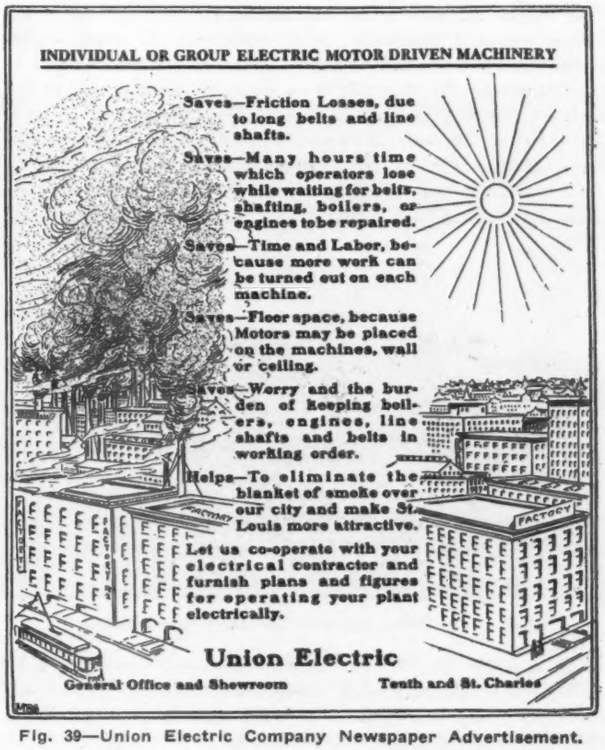

INDIVIDUAL OR GROUP ELECTRIC MOTOR DRIVEN MACHINERY
Saves—Friction Losses, due to long belts and line shafts.
Saves—Many hours time which operators lose while waiting for belts, shafting, boilers, or engines to be repaired.
Saves—Time and Labor, because more work can be turned out on each machine.
Saves—Floor space, because Motors may be placed on the machines, wall or ceiling.
Saves—Worry and the burden of keeping boilers, engines, line shafts and belts in working order.
Helps—To eliminate the blanket of smoke over our city and make St. Louis more attractive.
Let us co-operate with your electrical contractor and furnish plans and figures for operating your plant electrically.
Union Electric
General Office and Showroom
Tenth and St. Charles

Fig. 39—Union Electric Company Newspaper Advertisement.

bar disappears in a shower of white sparks which, as they leave the wheel, change to amber and then to red. The name of the Union company is prominently shown in large letters above the emery wheel.

The company also has some ten other large electric signs in operation on various roofs throughout the city, using a total of about 5000 lamps in this way. These are mostly simple "card" signs, giving only the name and address of the company and some reference to its service. The various downtown plants, substations and offices of the company are also outlined in 10-volt tungsten lamps.

As billboard advertising is a popular means of exposition in St. Louis, the Union company has also entered this field with about 15 painted signs, the larger of which measure 50 ft. x 12

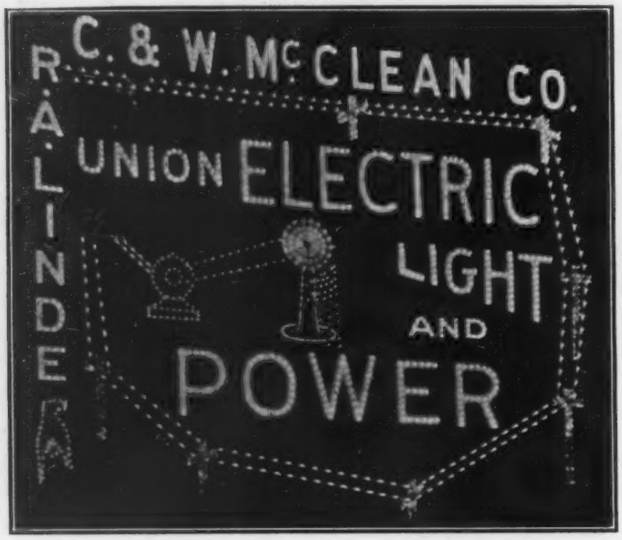


Fig. 40—Electric Sign of Union Light & Power Co., St. Louis.

ft. After dark these signs are illuminated by lamps placed at one-foot intervals in the borders. Both logic and rhyme are brought to bear on the reader, as Fig. 41 proves.

"Electric St. Louis," a popular-class monthly, which the Union company distributes to its customers, is prepared and published by a local advertising concern, the assistance and suggestions of the central-station company being given in the arrangement of the reading matter. The publication is 10 in. x 14 in. in size, contains 18 pages, and is devoted to the introduction of commercial and domestic electrical devices in St. Louis. Its illustrations are usually made up of subjects of local elec-

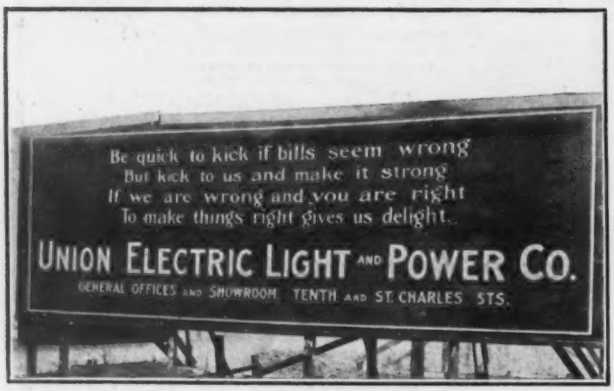

Be quick to kick if bills seem wrong
But kick to us and make it strong
If we are wrong and you are right
To make things right gives us delight.
UNION ELECTRIC LIGHT AND POWER CO.
GENERAL OFFICES AND SHOWROOM TENTH AND ST. CHARLES STS.

Fig. 41—Union Electric Company Signboard.

trical interest. The Union company delivers 23,000 copies of each issue to its customers, sends 2000 others to prospective electrical users, while 5000 copies are placed in 50 St. Louis drug stores for gratuitous distribution.

Seasonable reminders of the conveniences of electric service are printed on the backs of the monthly bills sent to customers.

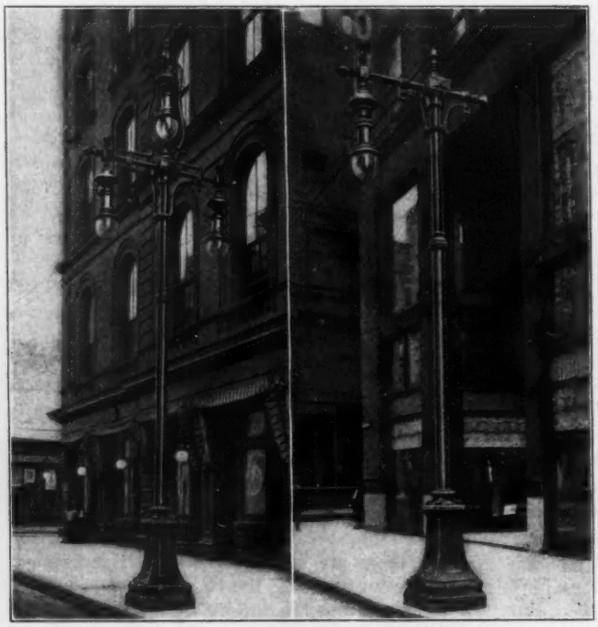
The commercial engineering department is carrying out an elaborate new-business campaign directed at interesting various tradespeople and prospective small motor users in the easier and improved production which electricity can provide for them, illustrating its arguments by examples of what others have done in the same fields. In this way a number of businesses are thoroughly circularized. Advance copies of newspaper advertisements relating to motor service have also been sent, before publication, to the various contractors and supply men in the city, advising them beforehand of what will appear, so that sales of apparatus and electrical installations can be made at the psychological moments created by the advertisements. This taking of the contractor or supply man into the confidence of the company also works to increase his interest and help in improving the central-station load.

Mr. F. D. Beardslee has charge of advertising and the solicitation of isolated-plant business.

STREET LIGHTING.

Certain to be the object of admiration of those in attendance at the National Electric Light Association Convention, as of all visitors to St. Louis, is the magnetite-arc illumination of Broadway. Eight blocks of the principal business section of this thoroughfare, from Washington to Elm streets, are lighted by 240 magnetite-arc lamps, rendering it probably the most brilliantly illuminated street of equal length in this country. The lamps are carried, three to the post, on ornamental standards set at distances of from 50 to 70 ft. apart, or about ten to the block. The bases of these standards are cast-iron pedestals of handsome design, 4 ft. high. From these rise 6-in. wrought-iron masts, 16 ft. in length, carrying 6-ft. cross-arms of 3-in. pipe. At the extremities of these arms two lamps are hung, bringing the lamps 18 ft. above the level of the street, while directly over the mast a hollow bracket supports the third lamp at a height of 23 ft. Ornamental cap pieces complete the arms, which are braced by tasteful brackets.

The magnetite-arc lamps are of General Electric manufacture; 211 are of the 4-amp, 300-watt type, constituting the



Figs. 43 and 44—Three-Lamp and Single-Lamp Standards.

special illumination, and operate from dusk to midnight—while scattered among these at approximately the same positions and intervals as in the rest of the downtown section, are 29 of the regular city 6.8-amp, 500-watt lamps, which burn all night. The Broadway lighting has been installed on a 10-year contract, for which a comparatively low yearly rate is made. The undertaking was carried out by the City Improvement Association, which apportioned the cost of the installation on a front-foot basis among the Broadway property owners. The subse-

quent cost of operating the lamps is similarly divided among the actual occupants of the property benefited.

The downtown district, bounded by Fourth, Washington, Twelfth and Market streets, is lighted by 428 6.8-amp, 500-watt General Electric magnetite-arc lamps. These lamps, which

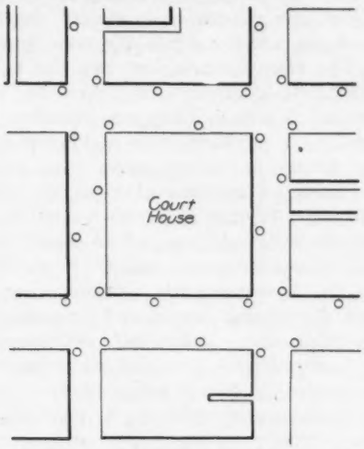


Fig. 45—Diagram Showing Positions of Posts.

constitute the regular city lighting for this section, are carried on ornamental standards having masts and pedestals similar to those on Broadway, but ending in a single arm, which carries its lamp at a height of 18 ft., and at a distance of 3 ft. 6 in. from the pole. The posts are staggered, being so arranged that, with those at the corners of intersecting streets, there are six to the block. As a result the street surface is brightly illuminated, and at night one can read fine print at any place on the street.

This magnetite display lighting has occasioned so much favorable comment among local people that merchants whose stores are on streets adjacent to the brightly illuminated district are applying for private or neighborhood extensions of the street lighting, while several isolated districts have also demanded to be supplied like their downtown neighbors.

The ornamental standards on which the downtown magnetite lamps are mounted were built and erected by the Union Electric Light & Power Company, under the direction of the electrical department. The complete equipment for this extensive installation was purchased and put into operation within three months, including the designing and devising of the arrangement of the lamp, station, and trimming equipment.

The Union Electric Light & Power Company, through the city lighting contract of the Seckner Contracting Company, which it controls, is also supplying energy to 1182 Adams-Bagnall 500-watt arc lamps, lighting the streets in the north and west portions of the city. The Seckner contract, at $96.50 per lamp per year, expires Sept. 10, 1910, following which the Union company itself has secured the new contract, at $50 per lamp per year, and will install exclusively magnetite lamps throughout the streets, to be lighted by electricity. The largest

Fig. 46—Extension Ladder Automobile for Trimming Downtown Arc Lamps.

portion of the outlying St. Louis street lighting, however, is yet done by means of incandescent-mantle gas lamps.

For trimming the downtown magnetite lamps, which for simplicity and sightliness are not arranged to be lowered from their cross-arms, an ingenious and effective automobile ladder truck has been devised. This consists of a single-cylinder, 10-hp Cadillac runabout chassis, on the rear of which two braced steel A-frames are erected. Bearings at the apex of each of these frames carry the pivot bar of an extension ladder, which can be locked into position at any angle through 30 degrees about the center, by a latch engaging a rack sector. As shown in Fig. 46, only one man is required, and by means of the extension ladder any lamp can be easily reached with the automobile standing at the curb. Two of these ladder wagons are in service, one for the trimmer and one for the troubleman, who restores service to the arc lamps at night. The 6.8-amp lamps burn 75 hours, and the 4-amp lamps 200 hours, with each renewal of the electrodes.

Fig. 42—Magnetite-arc Illumination, Broadway, St. Louis.

LACLEDE GAS LIGHT COMPANY

SALE OF ELECTRICITY.

IN May, 1890, when its 3000-kw generating station at Mound Street and the Levee was put into operation the Laclede Gas Light Company began to supply electricity in St. Louis. This plant was destroyed by fire Jan. 16, 1907, since which time the Laclede company has purchased all of its electrical energy from the Union Electric Light & Power Company for resale to its own consumers.

The Laclede company supplies 110-220-volt, single-phase, 60-cycle energy for all lighting service, and 500-volt, direct-current energy for motor service. Its lines traverse chiefly the west and north parts of the city, besides the downtown underground district, where it operates under the name of the Phoenix Heat, Light & Power Company. At the present time the Laclede company has in all about 3000 electrical consumers, whose maximum demand is about 2000 kw, and their total consumption about 500,000 kw-hours per month. The company operates no substations or converting equipment, purchasing its energy directly from the 2300-volt alternating-current and 500-volt direct-current buses and feeders of the Union company's system, at various points convenient for distribution.

The 60-cycle energy for lighting is sold at the following rates per kw-hour: First 2 kw-hours, 12 cents; next 2 kw-hours, 10 cents; next 4 kw-hours, 7 cents, and for all additional, 4 cents. Five per cent discount is allowed for prompt payment of bills. The minimum monthly charge is $1 for lighting service. For the 500-volt direct-current motor service, the following schedule of charges obtains, a minimum charge of $1 per month being made for each hp of connected motors: First, second and third 100 kw-hours, 10, 8 and 6 cents, respectively; next 300 kw-hours, 4 cents; all over 600 kw-hours, 3 cents.

Of course, by far the largest part of the Laclede Gas Light Company's business is in the manufacture of illuminating gas, its several plants in the city of St. Louis having an aggregate output of 15,000,000 cu. ft. per day.

To utilize the exhaust steam from the auxiliary engines employed in gas-making processes a 300-kw, low-pressure turbine-generator is being installed in the south side gas plant, which will supply part of the electrical demand.

The Laclede Gas Light Company will participate in the use of Mississippi River hydroelectric energy, brought from Keokuk, 140 miles away, having contracted for 5000 kw. As an auxiliary to this transmission it contemplates erecting a 7000-kw steam-turbine generating station on the site of the plant which burned. The company, which was until recently controlled by the North American Company, is now owned entirely by St. Louis interests. Its officers are: Vice-president and general manager, Mr. C. L. Holman; secretary, Mr. W. S. Dodd, and treasurer, Mr. W. H. Whitton. Mr. William Gallaher is electrical superintendent for the company.

ELECTRICAL SUPPLY IN ST. LOUIS COUNTY

SALE OF ELECTRICITY BY THE KING ELECTRIC COMPANY AND THE SUBURBAN ELECTRIC LIGHT AND POWER COMPANY.

ST. LOUIS County, outside of the corporate limits of the city of St. Louis, is supplied with electrical energy for lighting and motor service by two associated companies, the King Electric Company and the Suburban Electric Light & Power Company. These organizations operate no generating stations, but purchase energy from the 60-cycle primaries of the Union Electric Light & Power Company of St. Louis, and distribute to their customers over their own wire plants, which comprise some 160 miles of pole line.

As shown by the accompanying map of St. Louis County, the territory of the companies is divided nearly equally by the Clayton Road, which extends due west from the city of St. Louis. The King Electric Company has a 50-year franchise for supplying electricity to consumers in St. Louis County north of this road, while the Suburban company has similar rights in the territory south of the line.

The King Electric Company serves 1112 customers, scattered over a suburban territory of 77 square miles, and also furnishes the street lighting in Ferguson and Wellston, where it has installed, respectively, 125 and 80 series tungsten lamps. The switching and distributing station for the King territory is located at De Hodiamont, and contains a switchboard with incoming and distributing panels, and boosting regulators of the hand-operated type. Additional switchboard equipment has recently been ordered. The company owns about 70 miles of pole line, including several single lines, up to nine miles in length. About 165,000 kw-hours is marketed monthly by

Fig. 47—Map of St. Louis Territory.

the King company. Its territory includes several large customers, among whom are the Delmar Gardens, with a connected alternating-current load in lamps and motors of 600 kw; the Suburban Garden, 350 kw, and the Lewis Publishing Company, whose direct-current load of 300 kw for printing-press motors is supplied in summer through a converter. The Lewis company operates its own power and heating plant in winter.

The lines of the Suburban Electric Light & Power Company penetrate 51 square miles of the southwest section of St. Louis County, supplying energy to 1500 customers. Street lighting in Webster Grove and Maplewood is furnished, respectively, by 260 and 80 series tungsten lamps. The switching point is at Webster Grove, where equipment is installed similar to that at De Hodiamont. Ninety miles of overhead pole line are now in operation. The monthly sales of the Suburban company aggregate about 70,000 kw-hours. Jefferson Barracks, with a connected load of 500 kw, also receives energy from its lines. For the operation of hoisting and grinding motors in several clay mines in this territory a relatively small quantity of 500-volt direct-current energy is purchased from nearby railway feeders.

The scattered population of the suburban areas served by these companies has brought about some interesting methods of new business-getting, lamp-renewals, meter-reading and advertising. The former practice of allowing neighboring druggists a commission for exchanging lamps was discontinued when it was discovered that during slack business periods these men frequently went about soliciting renewals and taking

in lamps whose useful life was not nearly exhausted. A new-business solicitor is now employed who drives over the lines once or twice every month in his special wagon, containing a complete exhibit of electric heating appliances, irons, toasters, etc. At these periods this solicitor makes regular calls on the neighborhood druggists or storekeepers, whom the customers are asked to notify when renewals are needed. The storekeeper is paid for transmitting these notices, and the solicitor then drives on to the customer's residence, using his judgment about making renewals, and also frequently gaining the ear of the customer for the sale of some heating device. This renewal work is performed in addition, of course, to the solicitor's other duties of new-business getting, and the sale of heating devices.

Each of the little towns served has its moving-picture show, and this medium for advertising the sale of electricity and electrical apparatus has been found to give excellent results in a region where local newspaper advertising would have to be inserted in a number of country papers at an expense probably out of proportion to the benefit received. The electric company provides the moving-picture showman with advertising slides, which are run in at intervals, and for which service the showman is given a one-half cent per kw-hour reduction in the cost of his energy.

Motorcycles are provided for meter setters and troublemen.

The county companies have a standard residence lighting rate of 15 cents per kw-hour, with a discount proportional to the size of the bill. A minimum bill of $1.20 is rendered for the first kw of connected load, which is increased by 60 cents for each additional kw. The commercial lighting and motor service rate is 12.5 cents per kw-hour.

The officials of the King Electric Company and of the Suburban Electric Light & Power Company are: President, Mr. A. C. Einstein; secretary and treasurer, Mr. W. H. Alford; commercial agent, Mr. William Overing, and engineer, Mr. R. R. Ripley. Mr. S. H. Wallace is superintendent of the Suburban Company, and Mr. G. S. Neeley of the King Company.

Mr. A. C. Einstein, president and general manager of the St. Louis County companies, was graduated from the manual-training school of Washington University, St. Louis, in 1884, and after varied engineering experience in railway and mining

Mr. A. C. Einstein,
President and General Manager, King Electric Company.

work in 1894 headed his own company engaged in general construction and engineering work. From 1894 to 1898 he served as president and general manager of the electric light and street railway properties of Paducah, Ky. During the nine years ending with 1907, Mr. Einstein was president of the Eagle Generator Company, during which period he invented a number of pieces of acetylene gas-generating apparatus. He first became associated with the Suburban Electric Light & Power Company in 1901, and in 1906 purchased the King Electric Company, of both of which companies, as well as of the St. Louis County Gas Company, he is now the active president and general manager.

It is probable that with the bringing of hydroelectric energy to St. Louis, from the Keokuk development on the Mississippi River, the county supply companies will arrange to take a total of about 5000 kw, tapping the 110,000-volt transmission line at a point where it traverses their territory outside of the St. Louis city limits.

KEOKUK HYDROELECTRIC PLANT

MISSISSIPPI RIVER ENERGY FOR ST. LOUIS.

HYDROELECTRIC energy from the Des Moines Rapids of the Mississippi River, 140 miles distant, is promised for St. Louis within three years by the engineers and promoters of the great dam and water-power development now under construction at a point opposite Keokuk, Ia. The initial installation will be rated at 100,000 hp; later this will be increased to 200,000, and ultimately even to 300,000 hp, developing the full power of the river at this point. Of the first amount, which is scheduled to be ready in 1913, 60,000 hp has already been contracted for in St. Louis, at the rate of $25 per horse-power per year, by the Union Electric Light & Power Company, 27,500 hp; United Railways Company of St. Louis, 27,500 hp, and Laclede Gas Light Company, 5000 hp.

As this quantity is subject to a 10 per cent increase during two hours each day, one hour in the morning and one in the evening, it will be seen that provision has really been made for a maximum demand of 66,000 hp. The energy will be transmitted from Keokuk to St. Louis over a 110,000-volt, 25-cycle, steel-tower transmission line on a private right-of-way.

For a distance of 12 miles above Keokuk the Mississippi River is marked by shallow rapids, and in this distance undergoes a total fall of about 22 ft. A number of years ago, as an aid to navigation in the river, the Government constructed the present canal and locks around these rapids, conveying vessels between the upper and lower levels in three approximately equal lifts.

The general scheme of the future hydroelectric development involves the construction of a great concrete dam at the foot of the rapids, near lock No. 3 of the present canal. This structure will raise the level of the river at this point by about 30 ft., submerging the present rapids, canal and some adjacent lowlands, under from 10 to 30 ft. of water, and creating a long artificial lake, about a mile in width and extending almost 40 miles up-stream. A single lift lock and a dry-dock are to be built as part of the dam structure. River navigation will profit by the creation of the deep, wide lake formed in place of the present rapids, as well as by the reduction in the number of lockages from three to one. The immense quantity of water impounded in the artificial lake, which will have an area of about 36 sq. miles and a depth of from 10 to 35 ft., is also expected to be of value in regulating the varying stages of the Mississippi River below Keokuk.

The accompanying perspective sketch of the water-power dam, made under the direction of the engineers who are carrying out the development, shows the dam structure and generating station as they will appear when completed. Over-all the dam will measure 4700 ft. between the abutments, which are locked into the solid rock of the Iowa and Illinois bluffs. The spillway section of the dam will extend 4400 ft. from the Illinois abutment and will comprise practically a monolith of massive concrete without reinforcement, having its base firmly seated into a trench cut in the bed rock. From the west end of this spillway structure and at right angles to it, the power house will extend 1400 ft. downstream, paralleling the Iowa shore at a distance of about 300 ft. The second cross-stream

section of the dam, from the lower end of the station to the adjacent shore, will contain the dry-dock basin and the ship lock, 160 x 450 ft.

The principal spillway section of the dam containing the

Fig. 49—Construction Work on Illinois Shore of Keokuk Dam.

floodgates will be 4400 ft. long, 37 ft. high and 43 ft. wide at the base. There will be 116 of these steel floodgates, each 30 ft. wide and 11 ft. high, supported on concrete piers 8 ft. thick and 29 ft. wide, built into and forming a part of the main dam structure. The downstream face of the spillway wall has been designed with a special curvature which will deflect the water horizontally away from the toe of the dam. The gate piers will also carry an arched passenger bridge from which the gates are to be handled by motor-driven crab-hoists. By manipulating these gates it is planned to keep the water in the lake at practically a constant level during the entire year. The flow of the river at this point averages about 200,000 cu. ft. per second, sometimes reaching 375,000 cu. ft. in time of flood. At present the height of the river varies as much as 20 ft. from extreme low water to its flood stage. The construction of the dam will secure for normal operation practically a 6-ft. depth over 36 sq. miles for the regulation of this flow. The operating head on the hydraulic machinery to be made available by the dam will vary from 21 to 35 ft.

The power house will be 1400 ft. long and 123 ft. wide, paralleling in its major dimension the river banks. Its height from foundation to roof will be 133 ft. The foundation structure, like that of the spillway section, will be of massive concrete, in which will be molded the intake and discharge passages and water-wheel chambers. The superstructure of concrete, brick and steel, will contain the 30 generators and the accessory transformer and switching apparatus, the latter equipment to be located on a second-story gallery in the central section of the building. In the design of the power house space has been provided for 30 generator sets, although the first installation will number only 15 of the 5000-kw units necessary to develop the first block of 100,000 hp. The turbine-generator sets will be of the vertical-shaft type, the weight of their moving parts being carried on heavy thrust bearings. Each unit will comprise two turbines, situated in the submerged wheel chambers, both driving on the same shaft the generator located at the power-house floor level. The units will be provided with individual regulating and auxiliary apparatus.

For protecting the water-wheel intakes against floating ice and river refuse an arched concrete fender 2800 ft. long will be built out from the power house, extending upstream in a sweeping curve to the Iowa shore. Provision will be made for allowing vessels to pass through this fender, as it becomes necessary for them to reach the lock and basin just below the power house in order to gain the lower level.

For the construction of the dam and the hydraulic works it is estimated that there will be required 500,000 cu. yd. of masonry, 500,000 bbl. of cement and 7000 tons of steel.

The first transmission line to be built will probably be that supplying 110,000-volt, 25-cycle energy to St. Louis. This will be composed of several circuits carried on suspension-type insulators from steel towers erected on a private right-of-way. The straight line distance from Keokuk to St. Louis is 140 miles and the length of the transmission line will probably not exceed this greatly. Entering St. Louis, it is planned to bring the line over a private right-of-way now occupied by a suburban railway company to a transforming and frequency-changing substation near the center of the city, where the received potential of 100,000 volts (allowing for 10 per cent line drop in transmission) will be lowered to a suitable value for conversion to the local electrical requirements.

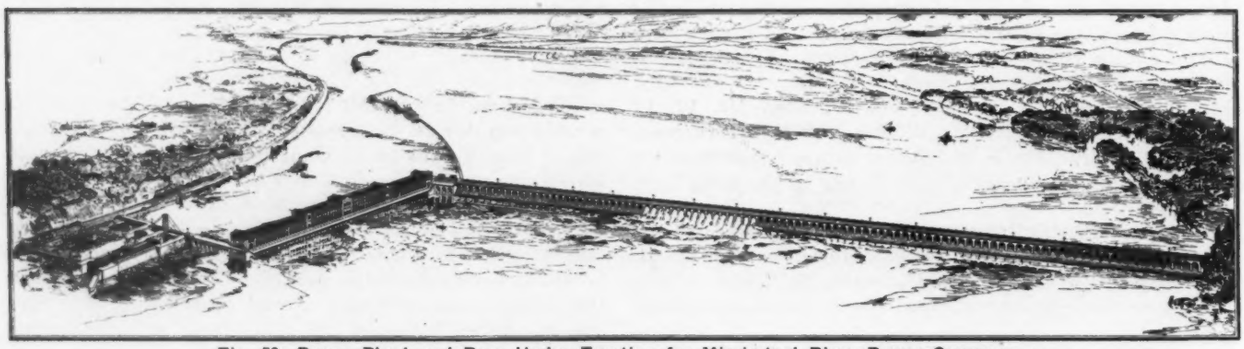


Fig. 50—Power Plant and Dam Under Erection for Mississippi River Power Company.

Other lines will be built to supply energy to neighboring communities. Within a radius of 40 miles of the Keokuk site there is an aggregate population of 200,000; within 100 miles, 1,500,000, and within 150 miles, 4,000,000. In considering the transmission of large quantities of hydroelectric energy to St. Louis at a distance of 140 miles, it also is of interest to recall

Fig. 51—Mississippi River Opposite Keokuk, Showing Site of Dam.

that another great city, Chicago, lies only 225 miles away. Among the neighboring cities and towns which will receive energy from the Keokuk plant, coincident with the transmission of energy to St. Louis, are Quincy, Burlington, Keokuk and Hamilton.

Permission to construct the Keokuk dam was granted by an act of Congress, Feb. 9, 1905, which stipulated that work should be commenced within five years and completed within ten years from that date. Difficulties in securing capital and in obtaining flowage rights over the land to be submerged delayed the actual beginning of work until January 10 of this year, when with hardly a month remaining until the expiration of the Government franchise, construction was begun in earnest and has been actively pushed without interruption to the present time.

On May 1 the total amount of excavation completed was estimated at 30,000 cu. yd. of rock and earth. The work to date has consisted largely of stripping the soil and debris from the quarries and site and in putting up auxiliary construction houses. After the work of placing the concrete commences it is expected that the completion of the structure will proceed rapidly. A method of traveler cranes is to be used, similar to that employed in the record work of the McCall Ferry dam.

The engineers estimate that the hydraulic and electrical equipment will be ready to start up and deliver energy within 30 months, although observers who have examined the tremendous task before the constructors do not set so early a date as this.

The total cost of the undertaking is estimated at from $15,000,000 to $20,000,000; of this amount about $1,400,000 has been expended in securing flowage rights on land which will be submerged, the largest item being an award of $350,000 to the Chicago, Burlington & Quincy Railway, whose present right of way on the Iowa bank of the river will be overflowed for a distance of 12 miles.

The hydroelectric development will be operated by the Keokuk & Hamilton Water Power Company, of which the officers are: Mr. H. L. Cooper, president; Mr. William Logan and Mr. W. V. H. Powellson, vice-presidents, and Mr. J. P. Allen, secretary and treasurer. The board of directors is made up of the officers just named, together with the following gentlemen: Mr. J. H. Drabelle, Mr. D. P. Cooper, Mr. J. M. Hunter and Mr. H. K. Herrick.

The distribution and sale of the electrical energy thus developed will be conducted by the Mississippi River Distributing Company, which will build and operate the transmission lines to St. Louis and other points. It is generally understood that this company will purchase energy from the water-power company at a rate of $18 per hp-year on a 60-per cent load factor, reselling this energy after traversing its transmission line at the rate of $25 per hp-year in the case of the St. Louis contracts. This rate will make the purchase price of Keokuk energy by the St. Louis companies approximately 0.6 cent per kw-hour—a figure with which, it is said, the present cost of steam-generated energy in St. Louis compares favorably.

LEAGUE OF ELECTRICAL INTERESTS

ST. LOUIS' SOCIAL ORGANIZATION FOR ADVANCING ELECTRICAL INTERESTS.

AS an organization of those locally identified with the electrical industry, the invitation to hold its 1910 convention in St. Louis was extended to the National Electric Light Association by the League of Electrical Interests of St. Louis. This league was organized last winter for the purpose of bringing together in fraternal spirit and co-operation, the men of St. Louis interested in the professional, financial, commercial, legal and patent aspects of electrical activity, thereby forming a body of recognized standing and influence in the city, to give timely and careful consideration to local electrical questions affecting the public interest or having a bearing on the conditions of electrical trade.

The League has 168 members. It holds no regular meetings but is assembled at intervals, by notice, when some electrical man of prominence gives an address. The talks given so far have dealt with the important, broader questions of electrical growth. The authority given these discussions by the eminence of the speakers has resulted in the acceptance of invitations to the meeting by many prominent non-electrical St. Louis citizens. Recent speakers before the League were Mr. T. C. Martin, "The Status of Our Electrical Art"; Mr. H. L. Doherty, "The Treatment of Quasi-Public Corporations by the Public"; Mr. Frank Frueauff and Mr. F. W. Lehmann. The present method of holding the meetings and discussions of the League in the evening following a dinner at a downtown club has proven very popular and more satisfactory than the former noon luncheons of the local electrical men, held under the auspices of the Sons of Jove, of which the Electrical League is the outgrowth. A recent meeting of the League was attended by 183 persons, many citizens outside of the electrical interests having been attracted by the importance of the subject debated—public-service corporations—and the standing of the speakers, who were Mr. Henry L. Doherty and Mr. F. H. Lehmann, one of the most popular and eloquent public men of the State.

Capt. Robert McCulloch, President.

The League of Electrical Interests of St. Louis is governed by an executive board of five, four appointed by the president, who is, ex-officio, the fifth member. At the organization of the League, Dec. 16, 1909, Capt. Robert McCulloch, president and general manager of the United Railways Company of St. Louis, was elected president. The executive board, whose membership is of a representative character, comprises Mr. H. H. Humphrey, for the consulting engineers; Mr. F. E. Newbery, for the contractors; Mr. Tom Maloney, for the manufacturers, and Mr. S. A. Hobson, for the jobbers. Mr. Walter Robbins, of the Wagner Electric Manufacturing Company, is secretary of the League.

Mr. Walter Robbins, Secretary.

An important and increasing aspect of the League's value in the community, outside of the electrical interests, is the work of the committee on "Questions of Public Interest," the chairman of which is Mr. George D. Rosenthal. In drawing up the new city charter the Board of Freeholders invited the recommendations of the League through this committee, as an aid in outlining the electrical features of the new ordinances.

The entertainment committee of the League is headed by Mr. L. M. Sperry, chairman. The present membership of the League, 168, is drawn from an estimated eligible list of 275 of those associated with the electrical interests in St. Louis. The dues of the League are $2 a year, with an initiation fee of $5 for new members. The class known as "sustaining members," composed of companies which agree to sustain all shortages during the year, pay yearly dues of $25.

SUPPORTS FOR TRANSMISSION LINES.

Some Mechanical Aspects of Flexible Tower Construction.

By C. T. Wilkinson.

A FUNDAMENTAL factor in energy transmission is the cost of the line. If the cost per mile can be reduced, then the radius of transmission from the generating plant can be correspondingly increased for a given capital investment. The area available for supply—that is, "the market" for energy, increases as the square of the length of the line. It is the object of this article to draw attention to some recent developments tending to reduce the cost and increase the safety of transmission lines employing steel structures.

MECHANICAL STRESSES.

From the mechanical point of view the worst stresses for which a transmission line must be designed are those due to the breakage of wires, accompanied at the same time by ice deposit and a high velocity wind blowing at right angles to the line.

The side stresses due to wind and the vertical stresses due to wire and ice are comparatively steady, but the stresses along the line when they occur, due to wire breakage, are in the nature of severe mechanical shocks. It is with special reference to the design to withstand these latter stresses that attention is here drawn.

The stresses due to wire breakage, like other mechanical shocks, may be met in two ways, namely, by impact on a rigid body and by absorption into a flexible system.

The object of the electrical engineer is to erect across the country wires insulated from the earth and from each other, and so long as the insulation is maintained, a slight movement in the direction of the line makes fundamentally no difference in the requirements. It is considered that the following remarks dealing with methods of absorbing wire breakage shocks into a flexible system, or by relief, as opposed to the present method of impact, may be of interest.

The first method considered is that of supporting the wires on structures of a flexible nature. That is to say, structures rigid to all stresses applied sideways or vertically, but capable of slight movement in the direction of the line.

The effect of wire breakage on transmission lines employing rigid steel structures depends on the design of the towers, the number of wires they support, etc. The damage may be limited to the twisting or stripping off of cross-arms or extend to the wrecking of several towers. If, however, the towers are designed with considerable flexibility in the direction of the line, the shock may be gradually absorbed and if the structure be properly designed and erected no damage to the tower should result from the breakage of the wires.

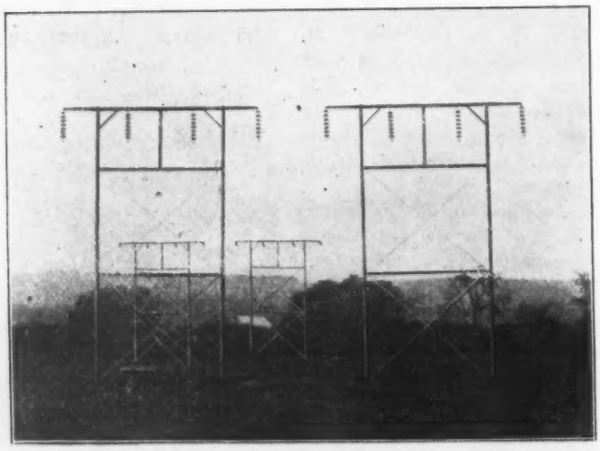


Fig. 1—Intermediate Towers, Experimental Line.

FLEXIBILITY.

In considering such a system the amount of safe bending of the towers, their distance apart, the number of wires, the amount of sag allowed must be held in mind. Slight bending or deflection of the tower in the direction of the line results in the shortening of the span on one side. This condition produces a difference in the stresses of the wires in the different spans resulting in a tendency for the wires themselves to take up some of the shock which was produced by the breakage of others. The redistribution of stress will cause the wires to assist in a remarkable degree in the support of the towers and prevent the development of too serious distortion.

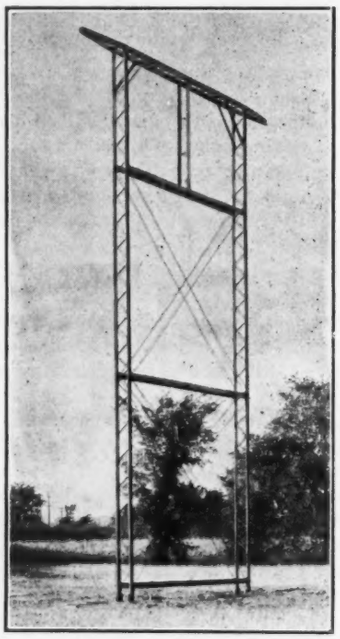


Fig. 2—Complete Intermediate Tower.

The name flexible towers has been given to the structures of the types shown in the figures. These structures consist of two uprights, cross-braced and carrying the necessary cross-arms for the support of the wires. The cross-arms are made heavy enough to transmit the maximum wire stresses to the tower.

Figs. 1 and 2 show towers on what is believed to be the first line built on this principle in the United States. Each upright of these structures consists of two standard 5-in. channel irons, cross-braced as shown and supporting a heavy 5-in. channel cross-arm. The uprights are approximately 19 ft. 6 in. apart, and the total length of the cross-arm is 30 ft. The towers carry four No. 3-0 copper cables and two 3/8-in. steel overhead ground cables, and are placed approximately 500 ft. apart. The height from ground to cross-arm is 43 ft.

Each of the uprights of the next structures designed consists of two standard channel beams set on edge, meeting together at the top to form a simple "A" frame. This line, which is shown in Figs. 3 and 4, is approximately two miles in length and has a maximum tower spacing of 400 ft., the average being about 350 ft. The towers support three No. 1 copper cables.

Fig. 5 shows a tower built for a 40-mile transmission line and designed to support three No. 4-0 copper cables and a 3/8-in. steel overhead ground cable. The line is laid out for an average spacing of about 400 ft., and is provided with "dead-end" towers of the usual four-footed, rigid type at intervals of approximately every mile.

Fig. 6 shows a test tower designed for supporting six No. 2 copper cables and one steel overhead ground cable. The height to the lowest wire is 38 ft. at the tower and it is intended to be used for a spacing of 530 ft. between towers on tangents. None of the above structures was designed for wind

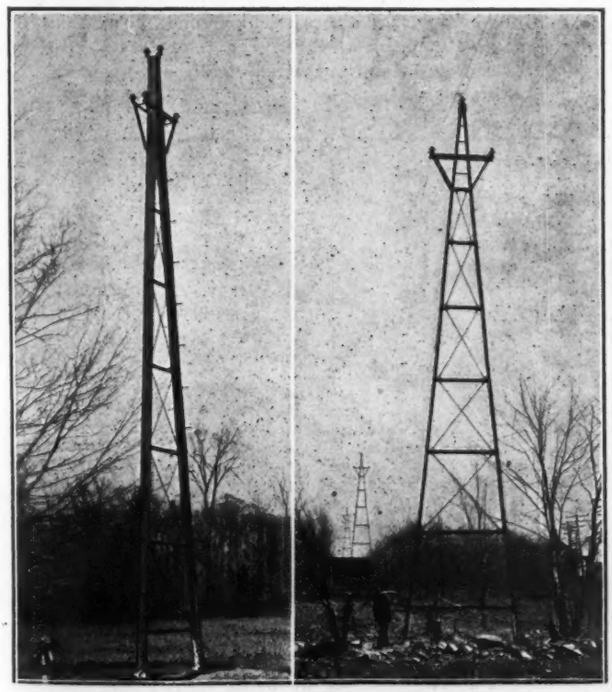
velocity of less than 65 miles per hour, actual, with an ice deposit of 0.5 in.

All of the flexible towers developed in this country differ somewhat noticeably from the first few lines built on this principle by Mr. Semenza, in Italy, in that the towers are spaced much farther apart and are of considerably heavier construction. The greater spacing enables the towers to be built of greater strength and with thicker metal for the same weight of structures per mile. In general, the structures developed may be found to have about the same strength as standard wooden poles of the same height. These towers differ also from some of the earliest European designs in that they are considered as intermediate towers, and it is recommended that approximately every fifth structure be double guyed, or in some cases a "dead-end" tower be placed approximately every mile. In this construction the intermediate towers are inherently stronger in the direction of the line than are the towers first developed in Europe, and in which that strength alone is not depended upon, but these intermediate structures are considered as floating on the wires between the solid structures placed at intervals, and, in case of rupture of the cables, the stresses will not alone be carried by these lighter towers, but will be transmitted to some extent to the "dead-end" towers.

After the designing of one or two lines on this principle the attention of those interested was drawn to their wide use in Europe, and the following examples may be of interest:

Fig. 7 shows the intermediate and "dead-end" structure used on a line in Pomerania. The towers on this line are spaced about 200 ft. apart on level country, and every eighth or tenth pole is of the "dead-end" type. The wires are of hard-drawn copper 12.5 sq. mm in section. This system has a total length of transmission line of 120 miles and is operated at 10,000 volts.

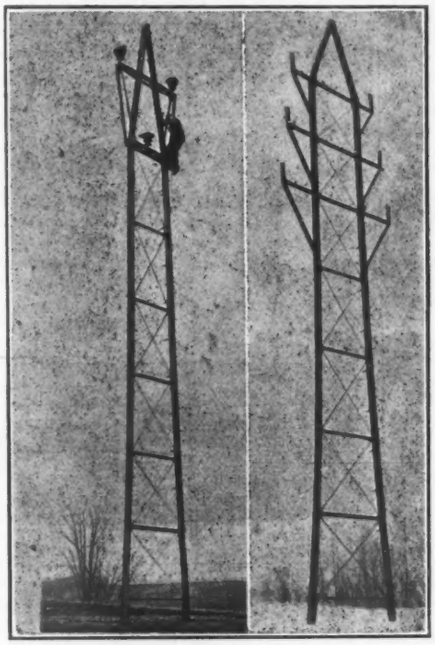
Figs. 8 and 9 show, respectively, the "dead-end" tower and one of the intermediate towers on a line in eastern Germany, and Figs 10 and 11 show the Victoria Falls line in South Africa. The latter line is designed for one 40,000-volt circuit consisting



Figs. 3 and 4—"A"-Frame Flexible Towers.

of three cables 70 sq. mm in section and two 12,000-volt circuits consisting of six cables 120 sq. mm in section; the spacing between towers is 500 ft. On this line every tenth tower has approximately twice the strength of the intermediate structures and is considered to be a "dead-end" structure.

A tower on a branch line of the Royal Trollhättan Canal & Water Works system is shown in Fig. 12. This line is 18 miles long and the towers have a minimum spacing of 600



Figs. 5 and 6—Flexible Towers.

ft. and a maximum spacing of 800 ft. The line carries six copper wires, 35 sq. mm in section, and one steel ground wire, 57 sq. mm in section. The line operates at 50,000 volts.

DESIGN OF THE TOWERS.

The object in the design of the towers is to provide ample strength sideways for wind stresses and in the direction of the

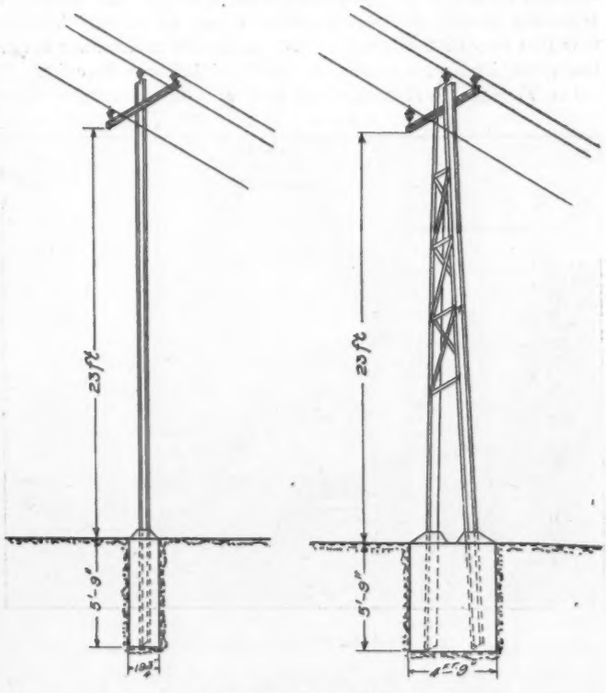


Fig. 7—Single and Double Masts.

line to make use of the strength of the wires themselves to assist the structures. For example, a line designed to carry six No. 2 wires and one ⅜-in. Siemens-Martin steel overhead ground wire would have a combined wire strength in all the wires of approximately 12,000 lb. after the breakage of two

wires. Neglecting for the moment the strength of the intermediate structures, themselves, in addition to the necessary strength for erection, stringing, etc., they must be capable of bending sufficiently to enable the remaining wires to tighten

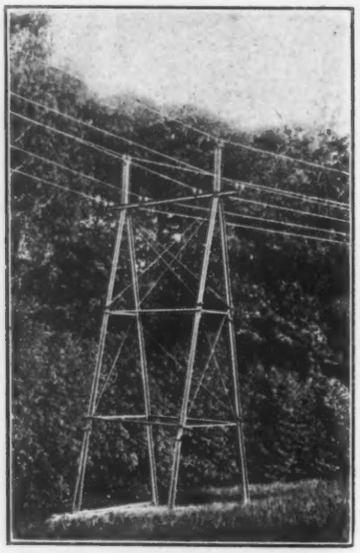


Fig. 8—Dead-End Tower.

up on one side and slack off on the other side in order to reach a condition of mechanical equilibrium.

The curve of Fig. 13 shows the relation between the sag of the wires and the excess length of wire over the distance between supports. The curve being based on an assumed span of 528 ft. This curve may be used to deduce in an approximate way the deflection due to the breakage of some of the wires. Consider the case of a flexible tower assumed to have no strength in the direction of the line, carrying seven wires attached on either side to rigid towers at a distance of 528 ft. from the central tower and set to a sag of 12 ft. Assume now that two of the wires are cut; after the momentary surge has spent itself, the conditions outlined below will exist.

Let T_1 = the total tension on one side of the tower; T_2 =

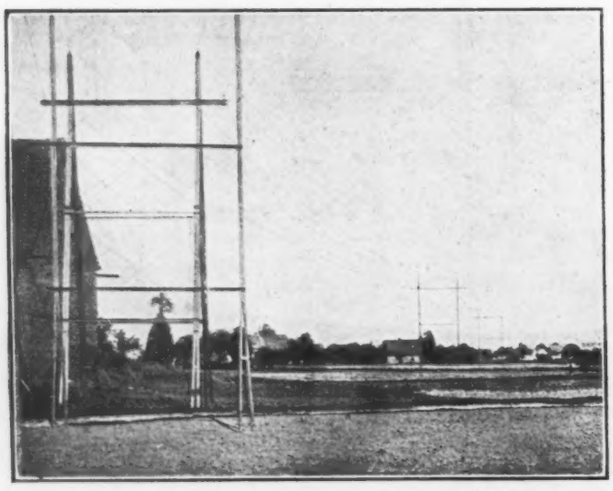


Fig. 9—Intermediate Towers.

the total tension on the other side; S = original sag before breakage (= 12 ft.); and S_1 and S_2 = sags after breakage. Now, $T_1 = T_2$; as an approximation it may be assumed that the sag in each wire is inversely proportional to the tension, and hence $5 S_2 = 7 S_1$. Assuming a straight-line law over the working range, $S_1 + S_2 = 24$; and $S_1 + 1.4 S_1 = 24$. Hence $S_1 = 10$ ft., and $S_2 = 14$ ft.

Referring to Fig. 13, it is seen that for a 12-ft. sag the excess length of wire was 0.72 ft. and for a 14-ft. sag it is 0.96 ft.; therefore, the increased length is 0.24 ft. = 2.9 in., or, allowing for stretch of the wires, say, 4 in. Semenza and other investigators have shown that this deflection is one-half

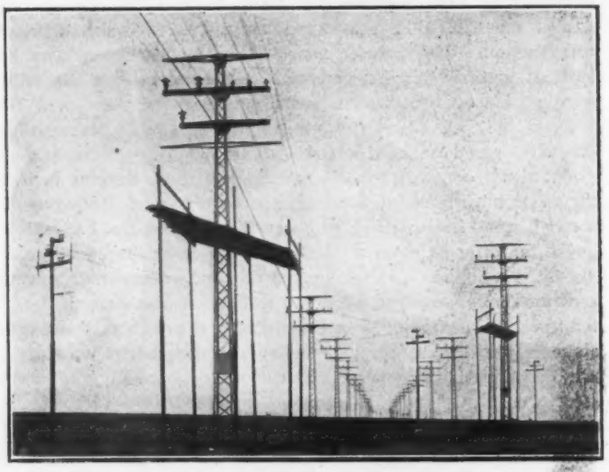


Fig. 10—Victoria Falls Towers.

what would occur if the wires were supported by a long line of flexible structures of the requisite strength. Hence, the deflection under actual conditions with the line built entirely of flexible structures will be 8 in. or less, depending on how frequently "dead-end" towers are used.

The excuse for the above treatment of the whole subject is that it enables one to obtain a simple grasp of the phenomena. The deflection determined as above will not be exactly one-half of the true value, but may be slightly greater or less than one-half the value, depending chiefly on the flexibility of the poles. In addition to the deflection referred to above, ample allowance must be made for the surging which will occur at the moment of the wire breakage.

It is of interest to note from the above that a very fair idea of the behavior of the whole line under conditions of wire breakage can be obtained from a test of one structure with wires strung up and supported rigidly on either side at the same distance as the tower spacing for which the line is

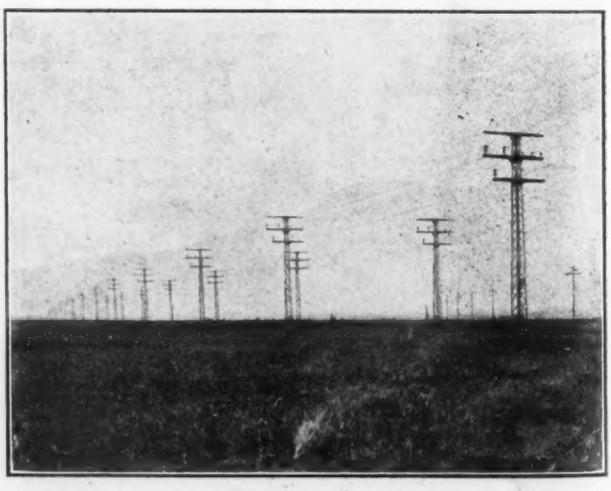


Fig. 11—Victoria Falls Towers.

being designed. Any number of wires desired may then be cut and the tower deflection thus observed may be doubled to ascertain the true deflection.

STEEL POLES.

Several types of standard steel poles which have been developed are interesting in this connection, since they represent very fairly the characteristics of wood poles with regard to flexibility. These poles, if used for light lines and set at

distances about 300 ft. apart give a price for line construction and a strength very favorable as compared with wood-pole lines, and have the advantages similar to those mentioned above for flexible towers. They have, however, the disadvantage that it is more difficult to make a good foundation for

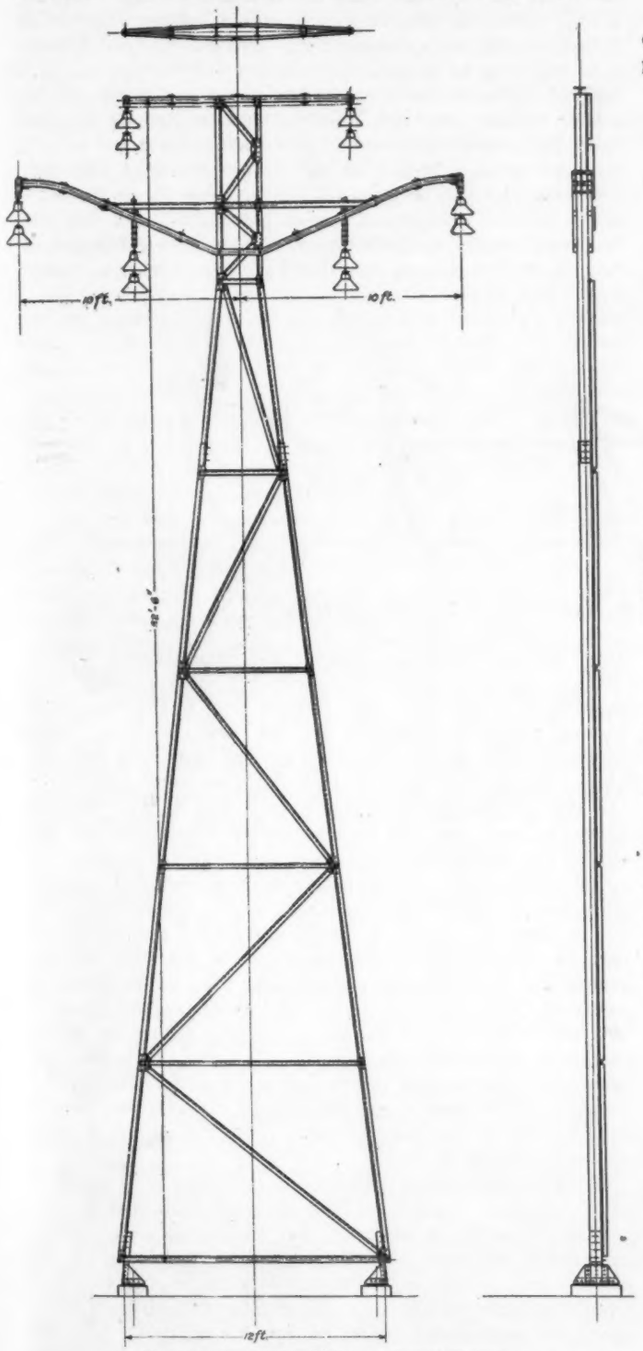


Fig. 12—Royal Trollhättan Canal Tower.

them and to preserve the proper alignment than is the case with the two-legged flexible towers.

THE COMPARATIVE COST OF FLEXIBLE TOWERS, RIGID TOWERS AND WOOD POLE LINES.

The author hesitates to give figures on costs for transmission lines since the conditions may vary widely, but in a number of cases which have come under the observation the cost of structure for a line employing flexible towers will be, roughly, from 65 per cent to 80 per cent that of the four-footed, rigid type, and the cost of the whole line completed and ready to operate may be expected to be from 60 per cent to 80 per cent of that for the four-legged tower construction. From experience with lines already constructed, employing the flexible structure, it would seem that their cost complete and ready to operate is only slightly higher than the cost of the wood-pole line—possible 30 per cent as an average; in one case it was exactly the same.

FLEXIBILITY INTRODUCED BY SUSPENSION INSULATORS.

The suspension insulator has become of interest to the tower designer since it permits stresses on the cross-arms to be applied as a direct pull, whereas the higher voltage pin-type of

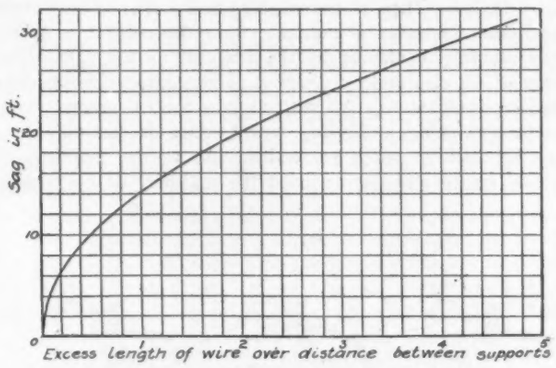


Fig. 13—Sag of Wire Between Supports.

insulator with the test load applied at its top caused considerable twisting stress on the cross-arm. Further, in case of wire breakage the total suspension length is thrown into the neighboring spans and their sag considerably increased thereby, resulting in reduced stresses on cross-arms.

LOOSE SLEEVES AND CLAMPS.

A very simple method of supporting the wire is to place it in a loose-sleeve wire holder with flared ends, such as shown in Fig. 14. This holder has given very satisfactory results for lines running on level country. Slight changes only would be necessary to make it adaptable to meet the conditions imposed by the majority of transmission lines.

Recently in a certain line on which the copper conductors were entirely supported by these sleeves a "dead-end" tower was overturned on account of a flood. No harm, however, was done to the neighboring tower. The wires slipped through the sleeves and prevented any excessive stresses on the structure. Had these towers not been provided with this or a similar method of relieving the stresses, there seems no doubt

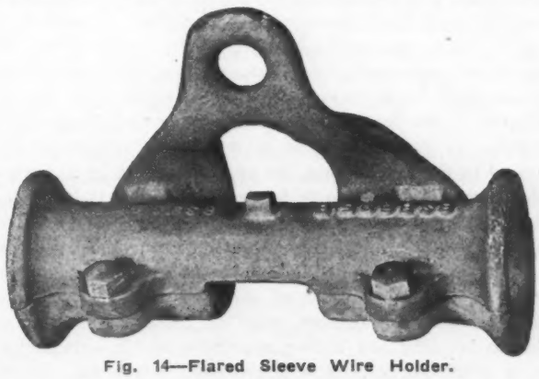


Fig. 14—Flared Sleeve Wire Holder.

that the giving way of all of the wires would have caused serious damage to the neighboring structures.

CONCLUSION.

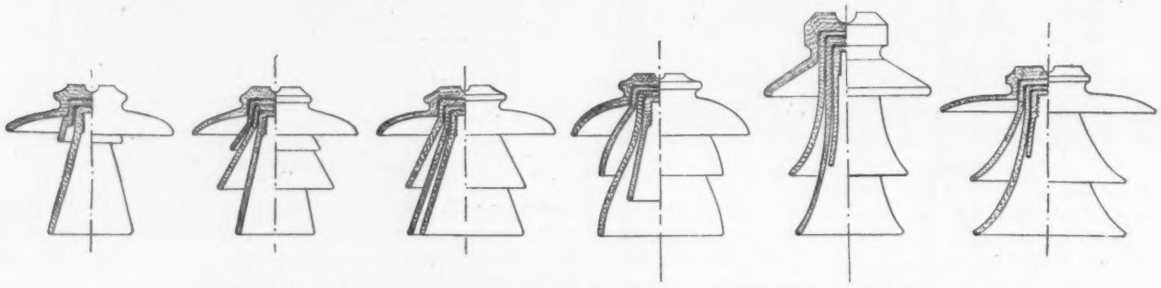
In conclusion, the attention of those interested in the flexible type of structure should be drawn to the necessity of care in its application, and it is suggested that the success met so far has been due largely to more careful consideration of the characteristics of the line as a whole than usual. There seems no doubt that this class of structure, just as is true of the four-footed type, has definite weight limits below which it is inadvisable to venture, and the greatest final economy of the line will probably not be obtained by any attempt to economize too radically in the amount of metal used in the structures.

TRANSMISSION INSULATORS.

Detailed Comparison of High-Tension Insulators of American and European Design.

By A. S. Watts.

THAT the subject of transmission insulators is one of utmost importance to the electrical world is without denial. That a thoroughly practical and successful transmission insulator is not as yet on the market is yearly, almost monthly, evidenced by the attempts on the part of engineers of all classes to produce a new and superior insulator design or combination. All such designs are of interest to the insulator-producing and using world, since it can only hope thus ultimately to reach perfection. As to the practicability of manufacture and operation of the majority of the designs offered, production and use have proven their faults in such a convincing manner that it seems useless to occupy a great deal of space with the renumeration of the sorrows which have resulted from errors on the part of both designer and manufacturer.



Figs. 1-6—Chronological Development of American High-Tension Insulators.

The designing of transmission insulators has been almost entirely in the hands of electrical engineers. Most of these men have studied the demands of the operating line, but since the manufacture of insulators is not in any way associated with the training of engineers for electrical transmission work, the result of their designs and demands is often startling. Moreover, the design of many an insulator has been undertaken with all the available data at hand and with all due consideration for the difficulties arising both in manufacture and operation, and yet this same insulator, for some unforeseen reason, failed to possess the insulating value possessed by other insulators of even smaller dimensions. It is too late, however, when an insulator is manufactured and installed, to do more than profit by the lesson taught. Yet, when it is realized that practically all the problems of high-tension transmission have developed in the past decade, the progress is not by any means discouraging. It must also be borne in mind that the investigation of power transmission insulation problems is not the simple matter that one finds in the study of most electrical problems. The development of electrical machinery has gone forward under the guidance of great companies with almost unlimited capital. Enormous sums of money have been expended in building and testing apparatus of all sorts and designs, a great portion of which proved worthless. On the other hand, the history of insulator development reads much as follows: The engineer in charge waits until about 90 days before he must have the insulators on the poles and then starts a canvass of past designs and a gathering together of his personal ideas of how an insulator should be constructed in order to be of the greatest efficiency. The result is a new design, on which bids are received and to the lowest bidder goes the contract. Then comes the delay due to the redesigning of the insulator in order that it may be manufactured. This delay is naturally annoying to the engineer, who cannot, as a rule, see the necessity of the changes proposed and he is further displeased at the time lost in beginning manufacture. The real annoyance begins, however, when the line is completed, the insulators are in place, the wire strung and the e.m.f. applied. Every engineer knows how many lines have never been operated at the voltage for which they were designed. A few have been raised from the original voltage without change of insulators, but many more have settled down to work at from 10 to 20 per cent less than the designed voltage. And in nearly every case the fault was in the insulator, either in design, construction or composition. By these repeated failures it is beginning to be generally realized that not enough preliminary research has been carried on in the matter of insulator design. And still, when an engineer designs an insulator, he hesitates to submit it to a manufacturer and have a test quantity made because of the expense connected with such a process. Instead, he waits until called upon for an insulator for immediate service, and rushes his untried idea into the field with results as above noted. Many electrical engineers may say in self-defense that they have been forced to design their ill-fated insulators because the manufacturer offered nothing that met their requirements. This is possibly in a measure true, but if one manufacturer went to the expense of making, in sufficient quantity for test, new designs of every sort and shape offered, he would expend yearly not only his meager profits, but also a portion of his working capital. On the side of the manufacturer, it may also be said that he should be, and generally is, conservative in his insulator designs. His design must come up to his guarantee in every respect, otherwise he is expected to replace them and sacrifice more than his profit. This has happened in a few instances and has undoubtedly created an undue amount of caution on the part of manufacturers. Furthermore, the patenting of any principle or design by the manufacturer has oftener proven a source of expense than of profit. The idea is slightly changed, bids are called for and the lowest bidder, whether he be the originator or not, gets the business. To bring suit against the competing manufacturer means that the engineer who let the contract will be angered and the patentee-manufacturer cannot hope for any of his future business. Such a condition is ruinous to the manufacturer.

If the development of high-tension insulators is to continue as in the past in the hands of the electrical transmission engineer, it seems highly important that he possess some reliable comparable data upon the relative values of the various insulators now in use, in order, not only to be able to select from those now available, but also to place an intelligent value upon any new design presented for his approval. At the present time such data is so meager that it is practically worthless. In tests made by engineers the data are generally so incomplete that the engineer has little more of value than might have been obtained from a common sense study of the designs tested. This is especially apparent when an attempt is made to repeat tests with other than the equipment with which the original tests were made.

German engineers have, probably, given more attention to uniformity of tests and a careful analysis of the results, but even here the data are very scarce and incomplete. However, when the development of the high-potential insulator is considered Americans may justly feel proud of the progress made in the United States as compared with the progress made in Europe along this line.

AMERICAN INSULATORS.

It hardly seems necessary to repeat the history of insulator development in the United States. However, for the purpose of comparison it may be advisable to refer to some of the characteristic types. In order to facilitate comparison all illustrations of insulators are reproduced to the same scale. Scarcely 10 years ago the first genuine high-tension insulator was offered for sale in the United States. Its construction was similar to the type shown in Fig. 1.

This insulator consisted of a porcelain head and intermediate shell manufactured separately and fused together during the burning process by means of a layer of glaze. With these was used a glass center which was attached to the other parts by means of Portland cement. This insulator did not prove all that was hoped for, but it was a great advance over the simple bell insulator which had been used up to this time and which was still in service in Europe.

The next step in insulator development was the lengthening of the intermediate shell and the introduction of a narrow flange on the under side of the top shell in order to lengthen the bearing surface between the top and second shells which were now united by use of Portland cement, as the glaze joint proved unreliable when subjected to great strains or sudden changes of temperature. The center was also now made of porcelain, thus eliminating the use of the glass, which caused trouble on account of its brittleness.

The next step was the extending of the head portion sufficiently to permit of the introduction of a fourth shell. This type is illustrated in Fig. 2.

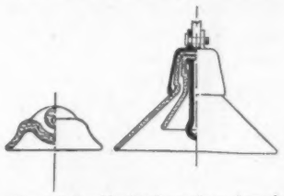
Up to this time the development of the insulator consisted merely in the expansion of the original type, thus furnishing greater striking and leakage distances. The only variation in this type had been to make the intermediate and inner shells in some instances slightly concaved to the weather, thus increasing the striking distance between the rim of each shell and the opposite surface of the next cell. This slightly increased the striking distance and also was a material advantage in manufacture, as it was found that when a long straight surface was made, there was a tendency for the clay mass to crowd to the rim of the mold without properly packing the intermediate portion. This tendency was overcome by the retarding action of the curved surface of the mold. Insulators like that shown in Fig. 2 proved very successful from the point of manufacture and also for employment on transmissions up to 60,000 volts, provided the operating conditions were good. If the conditions were severe or an addition of 6000 volts was considered, the mere increase of dimensions failed to give satisfactory results.

The result was a series of insulators varying considerably in form and possessing properties peculiar to themselves. In this class are the insulators illustrated in Figs. 3, 4, 5 and 6. The insulator shown in Fig. 3 was designed with the idea that, by having two large shells close together, one would obtain two surfaces to which the rain could not gain access and thus a notably increased efficiency under storm conditions was expected. The result, however, was that insects and dust collected in this protected place where the wind could not dislodge them, and this proved a conductor equal to the film of moisture accumulating during a storm. The proper cleaning of such an insulator also proved very difficult because of the narrow opening. In the manufacture much difficulty was encountered on account of the head, which was made very flat with abruptly turning rim. In the firing process this displayed a tendency to warp so that a valley was formed next to the tie-wire groove in which a small amount of water or dust could lodge. The very long straight inner shells proved also difficult to make successfully for reasons above noted.

Fig. 4 represents an insulator of almost the same dimensions as that in Fig. 3, but proving much superior both as regards operating efficiency and success of manufacture. This type has the peculiarity of having only convex surfaces exposed to the weather. If the rain comes from an angle less than 45 deg. to the vertical, the drops of water are inclined to glance down and off rather than up onto the overhanging shell. This insulator was never put into service in the United States, although many thousands were made and sent to Japan, where they proved very successful. This insulator presented no great difficulties in manufacture aside from such as must invariably arise from the handling of large pieces of porcelain.

Fig. 5 represents an elongated specimen of the type shown in Fig. 2 and had previously been extensively employed for 45,000-volt lines. This insulator was manufactured and employed only as a three-part insulator, the pin being cemented directly to the longest shell, which served also as center. Its failure when employed for high voltages lay in the fact that when put to the strain which its size seemed to warrant, it proved unequally balanced, causing the center to puncture during the stress of storm service. This difficulty was overcome by expanding the various dimensions sufficiently to permit of the introduction of a fourth shell, as here shown, thus placing two thicknesses of porcelain between the steel supporting pin and the first exposed surface. However, when thus redesigned, this type proved so heavy and so expensive to produce that it was never put into use. Regarding the manufacture of this insulator it is almost needless to say that the long straight surfaces presented great difficulties and the enormous losses in test were only indicators pointing to its ill fate when put into actual service.

In Fig. 6 is shown the Fig. 2 type expanded instead of elongated. This type proved very successful for voltages up to 75,000, but, like Fig. 5, the cost of production and the expense of installing such heavy insulators is in most cases not justified by the additional efficiency obtained. In the manufacture of such an enormous extending head as this insulator possesses much difficulty was naturally experienced on account of warping during the firing process. The most important fact brought out by the development of these large insulators is that an insulator of the type and size of Fig. 3 possesses so nearly equal value in service to that possessed by the larger types. When the enormously increased cost and the small increase in efficiency to be obtained by increasing the size of insulators past a certain point came to be known, there was a tendency to abandon these large types and return to more moderate sizes.



Figs. 7 and 8—Underhanging Insulators.

In the United States, as in Europe, the underhanging insulator came as a result of the discovery that for proposed 100,000-volt lines no pin-type insulator could be successfully employed. Various types of underhung or suspended insulators have since been offered, each having its peculiar advantages, as well as its disadvantages. In the design of an underhung insulator it is generally agreed that it must be so constructed that in case the insulator is destroyed, the line will not drop. Of the insulators so constructed, the best known types are the Hewlett insulator, Fig. 7, and the Duncan insulator, Fig. 8.

In the type illustrated in Fig. 7 the supporting cable passes into the porcelain, below and through, the loop which supports the next lower insulator or the transmission line. Thus there are two intersecting loops which certainly furnish absolute security against the dropping of the line. On the other hand, there is an opening in the top of the insulator into which water may enter and render the insulator liable to bursting by frost unless the curved hole is so bored that it tapers from each opening to the middle. As regards the manufacture of this insulator the author cannot speak with much authority, since he has had to do with the manufacture of only a comparatively

small number. However, the problem of boring a curved hole in an unburned mass of porcelain is certain to be not only a very difficult but a very uncertain task. Being unable to see through the holes, one can never be certain that fine cracks or flaws do not exist and the result is that all apparently good insulators must go to the kiln and be burned and tested before one can determine the proportion of rejection. The cost of burning a considerable number of worthless insulators must

Figs. 9, 10 and 11—German Insulators.

naturally add to the cost of the good insulators produced, since the insulators sold must bear the total cost of production.

Of the type illustrated in Fig. 8 the author's personal observation in connection with the manufacture of many thousand has convinced him that with the porcelain under compression as it is here, it is impossible to pull the bolt out of the cap with any amount of load which could be introduced by means of snow or ice added to the cable. In fact, the cable would itself part long before the strain on the insulator became enough to cause rupture. As to the problems of manufacture it may be said that the manufacture of this insulator does not present any problems other than would naturally be expected in an insulator with a small head and which is to be subjected to an excessive test and working strain. The Swedish engineer, Olav Ingeborg, in Nörköpping, who is transmitting 200 hp at 500,000 volts for use in his research laboratories, has recently equipped his line with this type of insulators exclusively after testing out practically all types. So much for American insulators.

EUROPEAN INSULATORS.

The development of transmission insulators in Europe has been along very different lines, although the original type employed was very like that first used for lower voltages in the United States. While, in Europe, much larger single pieces of porcelain are produced than in the United States, the demand for transmission insulators for voltages above 50,000 has been comparatively small. In fact, there is only one transmission line in Germany operating at more than 40,000 volts, that being the Moosburg-Munich line operating at 50,000 volts and delivering 4000 kw power. The only transmission lines in Europe operating at above 50,000 volts are: D'Orlo Toulouse, in France, operating at 55,000 volts; the Montiers-Lyon line, also in France, transmitting 4100 kw at 57,000 volts; and the Espanola-Madrid line, reported to be now operating at 66,000 volts. In none of these transmissions have they been forced to resort to insulators of extreme dimensions, so that there is little opportunity for comparison. Regarding insulator development in Europe, the Hermsdorf Parzellanfabrik patented in 1897 the "delta glocke" insulator, Fig. 9.

This type of insulator has been produced in all sizes up to about 12 in. diameter and throughout Europe is undoubtedly the most extensively employed type for moderate voltages. Of its merits much will be said later. It has the peculiarity of having only one thickness of porcelain between the line and the pin. In the manufacture of insulators in the United States this has been considered unreliable. Furthermore, with American materials, the production of large single piece insulators has not been successful. In Germany such insulators are produced by two different methods. One is to form a mass of body large enough to permit the bells to be turned out of the mass on a lathe while still in the half-plastic condition. The other is to make the bells separately and attach them while still plastic to the body portion of the insulator. This latter process is employed for the larger insulators and one rarely finds a German insulator that has punctured through the joint. Such joints have been attempted a number of times on insulators in the United States, but always without success. The author is convinced that the European clays lend themselves much more readily to this process than do American clays.

Another insulator used extensively in Europe is illustrated in Fig. 10. This type, known as the "rillen" insulator, depends upon the principle of having a number of "rillen" or grooves cut into the body shell at a point well up on the body shell so that they are protected from most direct rain by the overhanging head of the insulator. The value of a number of these insignificant grooves is remarkable. The Ph. Rosenthal Company, who produced this insulator, have developed it for higher voltages into the insulator shown in Fig. 11. This insulator is said to be serviceable for voltages up to and including 66,000 volts. In its manufacture the projecting flanges are all made separately and joined in the green condition to the body portion of the insulator. The production of this type of insulator was attempted in the United States some years ago, but was abandoned on account of the difficulties of manufacture.

Another insulator design, the uniqueness of which makes it worthy of attention, is shown in Fig. 12. This design was offered by Karl Kuhlmann, and is in substance the same idea as was suggested by an American engineer two or three years ago. This insulator would naturally fall in the same class as Figs. 5 and 6, since its enormous size would make its production and installation exceedingly expensive if not prohibitive.

In Germany, the Hermsdorf Porzellanfabrik have placed on the market a large variety of underhung insulators. The ones most highly recommended are of the types shown in Figs. 13, 14 and 15. Figs. 13 and 14 may be properly classed with the American type shown in Fig. 7. Fig. 13, however, has a straight hole for the upper loop which overcomes the danger of water collecting in this exposed opening. It also has the advantage of an extending shell which, of course, materially increases its efficiency.

Fig. 14 is practically the same as Fig. 7 in principle, but has incorporated as nearly as possible the type of the old delta glocke in an underhung insulator. That the type

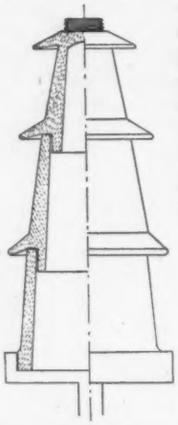
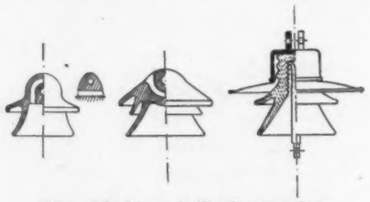


Fig. 12—Kuhlmann Insulator.



Figs. 13, 14 and 15—Suspension Insulators.

here also retains its value is indicated by a report of tests made by W. Weicker under the same rain and test conditions and with insulators of the same diameter:

Type	as	per	Fig.	7	stood	for	single	insulators	40,000 volts.
"	"	"	"	14	"	"	"	"	59,000 "
"	"	"	"	7	"	"	two	"	75,000 "
"	"	"	"	14	"	"	"	"	106,000 "
"	"	"	"	7	"	"	three	"	104,000 "
"	"	"	"	14	"	"	"	"	145,000 "
"	"	"	"	7	"	"	four	"	130,000 "
"	"	"	"	14	"	"	"	"	180,000 "

The European underhung insulator which most nearly resembles Fig. 8 is shown in Fig. 15.

This insulator is notable on account of having a thin enameled sheet-steel umbrella in place of the first porcelain shell. While the value of the insulator when dry is thus slightly reduced, its value under rain is increased, since with enameled steel a flatter, wider umbrella can be made than with an equal weight of porcelain. Under the same rain test conditions as

above Weicker found this insulator to possess the following values:

Type as per Fig. 15 stood for	single insulator	68,000	volts.
" " " " " " "	two insulators	125,000	"
" " " " " " "	three "	164,000	"

COMPARISON OF EUROPEAN AND AMERICAN INSULATORS.

Any attempt to compare, from the data available, the relative efficiency of European and American insulators would be not only worthless, but probably very misleading, except in cases where the tests were made at the same time and place and with the same testing equipment.

Friese in writing of high-voltage insulators figured the efficiency on the basis of the formula:

$$A \times B = \text{insulating value.}$$

$$\text{wherein } A = \frac{\text{insulating value under rain}}{\text{insulating value in dry condition}}$$

$$\text{and } B = \frac{\text{insulating value under rain}}{\text{weight of the insulator}}$$

As an example he compared a Hermsdorf delta glocke insulator and an American insulator tested under the same conditions and having practically the same value for A. The result of these tests are as follows:

	Efficiency under Rain.	Efficiency Dry.	Weight	A	B	Insulating Value.	Area of Top Shell.	Height.
	Volts.	Volts	Grams.				sq. cm.	cm.
German Delta-glocke	49,000	93,000	2125	0.53	23	12	240	19.5
American Insulator	49,000	92,000	2910	0.53	16.8	9	325	23.0

Thus, a delta glocke insulator of approximately 7 in. diameter by 7¼ in. high and weighing 4.7 lb. was shown to have an insulating value equal to that possessed by an American insulator of 8 in. diameter by 9 in. high and weighing 6.4 lb.

These figures prove beyond dispute the high efficiency of the delta glocke type of insulator and this is further confirmed by the remarkably high value of the underhung insulator (Fig. 14) designed after this model.

Despite these figures the European engineers have followed the American example in the design of insulators for higher voltages and have increased the size with more than a proportionate increase in weight.

On both sides of the ocean this has resulted in the discovery that size alone does not produce efficiency in an insulator, but

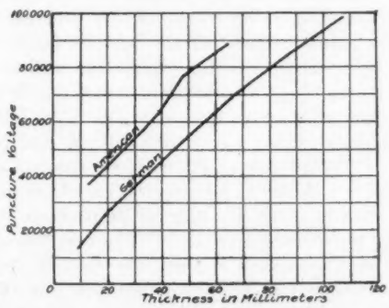


Fig. 16—Dielectric Strength of Porcelain.

that the volume of porcelain contained therein and the amount of surface as compared with the weight of the mass bear a definite relation to the efficiency of the insulator produced.

That the insulating efficiency of a porcelain mass does not increase in direct ratio with its thickness has been known to insulation engineers for several years. Researches which the writer is pursuing, upon the insulating value of porcelains from European materials, are not as yet in shape for publication, but herewith are given, in Fig. 16, the most recently published curve showing puncture voltages of various thicknesses of German porcelains. On the same plate is shown a curve of puncture voltages for various thicknesses of American porcelains. While the two curves were not made under the same test conditions and therefore the actual values therein contained cannot be compared, yet it is interesting to note the fact that the curves run practically parallel, which indicates that the influence of thickness upon insulating value is the same for European as for American porcelains.

The idea prevails in the United States that German products are prepared to stand a higher test than American insulators. While the writer is not prepared to say that they will not stand an equal or even greater relative test than the American in-

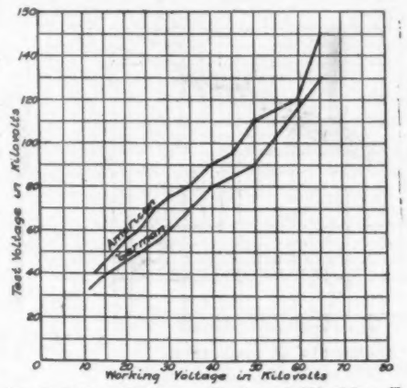


Fig. 17—Relation Between Test and Working E.M.F.

sulator, the fact remains that, based upon the relation of test voltage to working voltage, the German insulator is not ordinarily as severely tested as the American insulator. This is graphically shown in the accompanying curves, Fig. 17.

At no point does the German insulator bear as great a relative test as does the American insulator. In fact, the Verband Deutscher Elektrotechniker specifies a much more moderate test as follows:

For working voltages up to 5000 volts the test is double the working voltage.
For working voltages up to 5000 to 10,000 volts the test is 5000 volts above working voltage.
For working voltages above 10,000 volts the test is 1.5 × the working voltage.

These lower test voltages and the above data offered by Friese regarding the delta glocke insulator are probably responsible for the impression which prevails throughout both Europe and America that the German insulator is uniformly lighter for a given working voltage than the American insulator. While the delta glocke, and, in fact, all the smaller German insulators, including the rillen type, are relatively lighter than the American insulators, when the weight is compared with the test voltage instead of working voltage, it is found that the insulators of both lands fall within the same area. The writer has collected all the insulator weights available, numbering several hundred, and these are presented in Fig. 18, showing the areas covered by American and German insulators when weight is compared with test voltage, which is generally assumed to mean the actual capacity of the insulator or nearly so.

Thus it is seen that engineers, both in Europe and America, have reached the same point and can go no farther. They have proven only that a larger insulator does not possess proportionately increased efficiency. The possible reasons for this peculiar phenomenon the writer will attempt to discuss from the viewpoint of a porcelain chemist at another time.

In the study of insulators it may be said that all transmission insulators may be divided into two classes.

Class A.—Those constructed with the idea that they shall possess enough dry surface at all times to provide the necessary insulation.

Class B.—Those constructed upon the principle that porcelain surfaces, even when damp, possess a certain insulating value and if enough distance is provided the required insulation is secured.

The fault with class A is that it is practically impossible to

prevent some rain from spattering from the exposed surfaces up and onto the protected surfaces of the overhanging shell. This small amount of water is volatilized by surface leakage and forms steam which rises and hence remains under the overhanging shells of the insulator which protect it from removal by wind. If the rain is of any great duration, this accumulation of steam and vapor reduces the insulating value of the so-called dry surfaces to that of exposed surfaces of porcelain. If the insulator is selected with a sufficient factor of safety the sum of the insulating values of these wet surfaces,

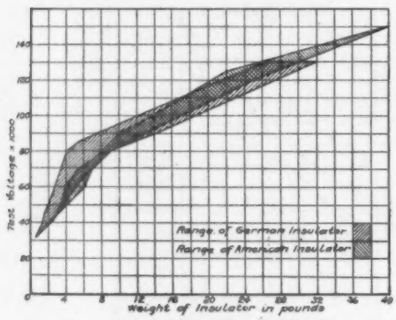


Fig. 18—Weight of Insulators.

Fig. 19—Suggested Type.

plus the insulating value of the inside surface of the center, which generally remains dry, since no spattering can reach it, furnish sufficient insulation to prevent interference with service.

All the types illustrated belong in this class, with the exception of Fig. 12, which plainly belong to class B.

The fault with class B is that it requires so long a surface that the weight, if designed, as here shown, is almost prohibitive, and yet the principle of class B provides the only certain means of insulation.

The principles of these two classes may be combined to produce a reasonably light, efficient insulator, and the writer believes that the solution of the insulator problem for voltages between 60,000 and 100,000 volts is along the following line:

It is known that a plain glazed porcelain tube (class B) 1 ft. long and 3 in. in diameter, when exposed to a rain of 1 in. in five minutes' precipitation, possesses an insulating value of about 30,000 volts.

If this same tube is corrugated uniformly its entire length, it is found that its value under the same test is increased to about 50,000 volts.

However, if the tube has undercut corrugations, the surface distance between ends is not only materially increased, but there is some protected surface to aid in insulation. These undercut surfaces not only have the advantage of being small and thus not permitting of any considerable vapor accumulation, but the fact that they are shallow enables the wind to free them of the vapor as fast as it accumulates. This may explain the remarkable value of the rillen in the Rosenthal insulator, Fig. 10. Be the explanation of the phenomena what it may, it has been proven beyond dispute that such a corrugated tube, 12 in. long and 3 in. in diameter, under rain test, as above, possess a value of about 100,000 volts. Moreover, a tube being of uniform surface design, the value may be increased by merely increasing the length of the tube.

By the employment of the above data the writer offers the insulator shown in Fig. 19. The advantages of such an insulator are many. It is not so heavy as the ordinary 60,000-volt insulator. It can be handled with much less danger of breakage in construction and when in place is practically safe against destruction by miscreants. In case of lightning it has no extending shells to be broken by the shock. The temporary short-circuit passes along its face rather than follow the small corrugations, with the result that it passes such a shock uninjured, whereas with the ordinary shell insulator destruction is certain. In the case of rain its exposed surface is small as compared with most 60,000-volt insulators, hence if it is necessary to keep the protected surfaces absolutely dry by surface leakage, the loss will be comparatively small. The only drawback to such an insulator is the difficulty of manufacture. However, such tubes are made with comparatively little loss in Europe, hence it may be assumed that a little experience would enable the American manufacturer to produce them with equal success. The design presents no difficulty which could be influenced by materials, as is the case where the parts must be made separately and united before burning.

In closing, the writer desires to call attention to what in his opinion is the greatest hindrance to progress in insulator development and which has caused more false impressions and trouble than all other causes combined. Reference is made to the absolute absence of anything like a uniform test for transmission insulators. Voltage and precipitation are spoken of as though they were standard factors not capable of influence by any varying condition. A given voltage may refer to a test with an equipment of 10-kw rating giving a spark like the striking of a match or it may refer to a test with a 1000-kw equipment giving a spark like the explosion of a bomb.

A given precipitation may refer to a fine driving mist or it may refer to a gentle downpour. And so with all the other data that are recorded on insulator tests.

The requirements for a standard test need not be such as to make its employment burdensome. It would be far better to have all tests with moderate equipment of a given type under standard specifications and thus have all data comparable, than to have such an accumulation of odds and ends as is being gathered under the present system. And, moreover, it is not at all in keeping with the progress in other branches of electrical engineering that the American engineer shall continue unable to interpret the results of another engineer's research, because of lack of complete details or because of non-uniformity of testing equipment. If the American transmission engineers would take up this matter with the insulator manufacturers the writer feels certain that they would find willing co-operation and that in a surprisingly short time a set of data which would be of inestimable value to the electrical world would be accumulated.

DETECTION OF FAULTS IN SMALL MOTOR ARMATURES.

By C. Nosrac.

WHEN manufacturing in quantities small motors, up to and including ½-hp machines, the problem of rapidly and accurately detecting the various faults which are liable to be encountered in motor armatures, such as short-circuits, open-circuits, rough commutators, noises due to not having the same number of turns in the various coils, vibration due to the armature being out of mechanical balance, and for the determination of energy consumption when running and when starting, becomes a matter which requires careful thought on the part of the manufacturer in order to keep down the cost of this portion of the constructive labor. The herein-described and illustrated devices have been successfully used by the writer at various times, and it is thought that they will prove interesting to others engaged in this line of work.

After the armatures are wound and the connections made on the commutator, they are taken to the testing-room and first tested for insulation between the shaft and the current-carrying parts, including the commutator and windings, by applying the voltage at which the test is to be made, to the shaft or laminations on one side and to the various bars of the commutator on the other.

This is accomplished by placing the armature in the fixture shown in Fig. 1, which consists of a cast-iron plate upon the upper surface of which is mounted a pair of V-blocks, which are insulated from the base by suitable fiber or hard-rubber bushings and insulation pieces. A binding post attached to one of these blocks serves to connect the latter to one side of the line from which the testing circuit is derived. Also mounted

upon the base and insulated from it, as shown in the drawing, is a block of steel through which slides a vertical steel plunger. This is pressed upward by a helical spring below and its upper extremity is conically pointed with a dull end. A binding post on this block is connected to the other side of the testing circuit, with a suitable double-pole switch intervening, and a bank of incandescent lamps connected in series with the fixture to

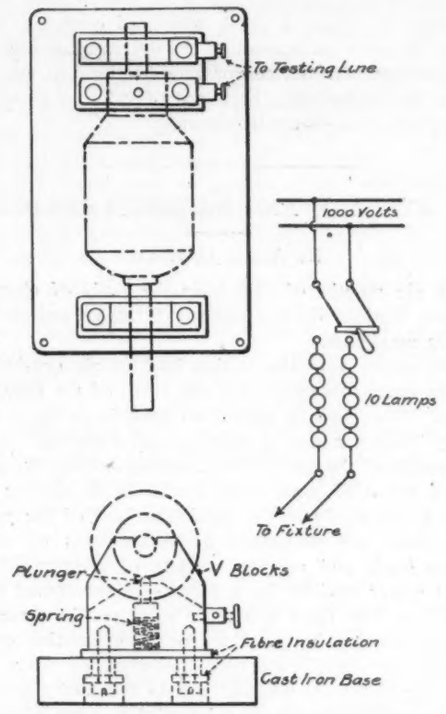


Fig. 1—Fixture and Connections for Insulation Test.

prevent excessive current in case a defect in the armature insulation exists.

To use this fixture, the armature is simply placed in the V-blocks, with the commutator over the plunger rod. The armature is then slowly revolved by hand and the plunger makes contact successively with all the bars in the commutator. Should a defect in the insulation exist, the lamps will glow.

The armatures are then placed in a fixture, shown in Fig. 2, which comprises a suitable cast-iron base upon which are mounted two shaft bearings to carry the armature. The one at the commutator end is rigidly attached to the base, but the other bearing is attached to a dove-tail slide, which operates in suitable ways in the base casting, and which, when slid out, will admit of the armature shaft being entered through the field structure and into the bearing at the commutator end, after which the slide is pushed in and the other bearing brought into position to support the armature. A standard set of field coils is rigidly mounted between these two bearings and in proper relation to the armature when in position in the fixture.

Attached to the bearing bracket at the commutator end are two swinging brush-holder arms, pivoted to a shouldered stud and provided with vertically extending handles, whereby the brushes may be lifted from the commutator. The brush holders are insulated from the arms which carry them and the brushes are fitted with screws projecting through the outer end of the brush-holder tubes. This serves to limit the distance they will project out of the brush tubes when lifted off the commutator. A double-throw, double-pole switch is mounted at the right-hand side of the fixture and connections are so made that by throwing the switch backward and forward the motor armature will reverse its direction of rotation. An ammeter of suitable capacity for the work at hand is connected in series with the fixture and serves to show the current consumed.

After placing the armature in this device and properly oiling the bearings, the switch is closed and the swing of the ammeter pointer noted, and when the armature has gained its maximum speed the ammeter reading is taken again. The reversing switch is then thrown back and forth several times, reversing the direction of rotation of the armature, and in this way short-circuits or open-circuits are detected. In the case of short-circuits, the usual electrical hum will be noticed as the armature picks up speed and the ammeter will show a larger reading in proportion to the intensity of the "short," while heavy sparking will usually prevail at the brushes. Open-circuits cause a heavy sparking at the time of reversal of rotation, giving the effect of a ring of fire around the commutator and are easily distinguished from "shorts."

While the armature is running at full speed the brushes are lifted from the commutator and if the armature is mechanically out of balance, its vibration is readily noticed, while in the case of a short-circuited armature the magnetic vibration, which is sometimes confused with the mechanical vibration, ceases immediately upon removal of the brushes from the commutator. A suitable clamp is then placed on the armature shaft and compressed until the armature is slowed down to approximately running speed under load and the ammeter reading again noticed.

While these various ammeter readings are of great value and serve as a means of checking the performance of the armature in most cases, it sometimes becomes necessary in case of an electrically noisy armature, and also in case of open-circuits to locate the defective coil and to determine the character of the fault. For this purpose the armature is placed in the fixture shown in Fig. 3, which consists of a cast-iron base, mounted upon the upper surface of which are two steel V-blocks, which serve as bearings into which the armature can be laid. At the

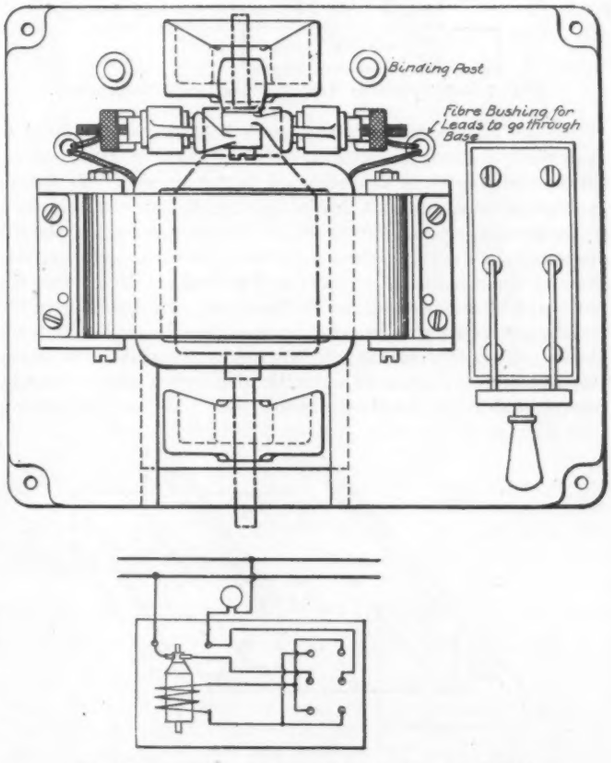


Fig. 2—Fixture and Connections for Running Test.

commutator end of the fixture is a fiber block which carries the brush tubes mounted in a horizontal position, and also accommodates two sliding steel plungers, which are pressed upward by two small helical springs below them and which are so located that when the armature is placed in the blocks the two plunger tips will bear against adjacent bars in the commutator. These two plungers are connected to a pair of binding posts, fastened

to the fiber blocks, to which are connected the "leads" of a milliammeter.

In the two brush tubes slide copper plungers, whose outer extremities are wedge-shaped, so as to bear on one bar of the commutator only, as shown. These plungers are pressed outward by helical springs in the brush tubes, and are fitted with projecting screws, through the brush tubes, to prevent the plungers being pushed out of the tubes when the armature is

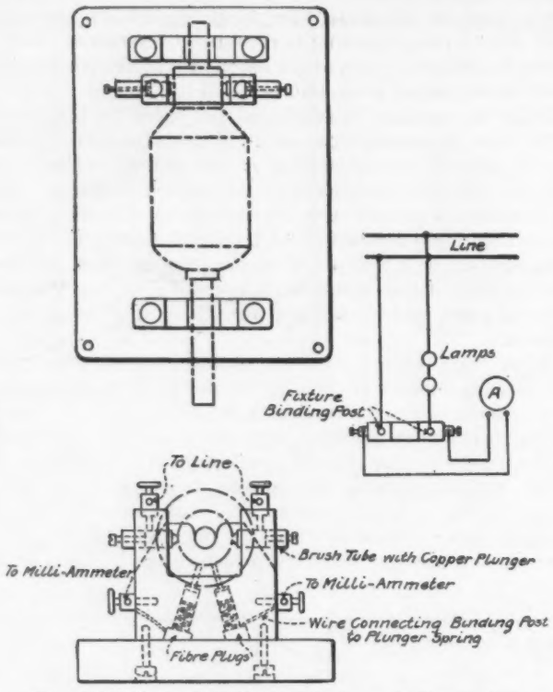


Fig. 3—Milliammeter Test Fixture, and Connections.

lifted out of the fixture. The brush holders are connected to two binding posts, mounted on the fiber block, and connections are made from these binding posts to the circuit of the proper voltage, with a bank of lamps in series, to limit the current flow.

By placing the armature in this device the two vertical plunger rods will successively make contact with the various commutator bars as the armature is revolved and the voltage drop across the coils will be indicated on the milliammeter. By determining the reading, with an armature having the correct number of turns in its coils, and dividing this reading by the number of turns the number of turns over or under the correct amount can be ascertained by the ammeter reading. In addition, the location

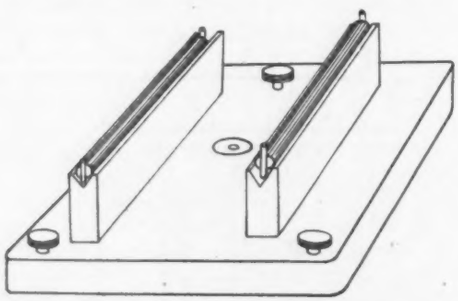


Fig. 4—Balancing Ways.

of open-circuit coils and slight short-circuits is readily found by the instrument reading.

For testing the armatures for mechanical balance a fixture shown in Fig. 4 is used. This device is composed of a cast-iron base carrying upon its upper surface two long V-blocks made of machine steel, carbonized and hardened and secured by suitable screws and dowels to the base. In these blocks are laid two round tool-steel rods, hardened and accurately ground to size, upon which the armature shaft will roll. Vertically projecting pins at either end of the blocks serve to prevent the armature from rolling off the ways, and three knurled-head screws, mounted in the base at approximately 120 deg. from each other, enable the fixture to be leveled. A small circular universal spirit level attached to the base serves to indicate when the device is level. It will be noticed that the armature bears upon the ways with only two points of contact, while with the usual construction of balancing ways the bearing will be a line contact instead of a point, which, of course, is much inferior to the latter on account of the decreased sensitiveness of the device. Similar devices or modifications to these herein described will undoubtedly be found of value to those engaged in the manufacture of small motors.

AVERAGE AND MAXIMUM LOADS.

By Alton D. Adams.

During six months of each year the loads of electric light and power stations do not usually go above one-half of the December maximum.

For the entire year the station load equals one-half of its maximum during no more than one-tenth of the time in some instances. The absolute maximum load is probably not carried fifty hours per year at most central stations.

As a result of these conditions, energy outputs are generally less than one-third what they would be if electric stations operated continuously at the maximum load of the year.

These facts are illustrated by the records of capacities, maximum loads and average outputs of a score of electric light and power stations for a recent year presented herewith. It is evident that facts like those disclosed in these records have important bearing on the type of generating equipment best suited to electric stations, the costs of operation, the capacity for additional loads at certain times of day and year, and on rate schedules that are intended to vary with the cost of rendering the service.

It is thus a question whether engine equipment that has to operate only from one to five or ten per cent of the total number of hours per year should be of the most efficient type with the increase of investment that this involves. There is some point where high efficiency during short hours of operation is more than offset by the greater charge for interest, depreciation and repairs.

For stations that work with average 24-hour loads that are only about one-quarter of the yearly maximum, much remains to be done in the way of electric heating, the charging of storage batteries to displace engines in isolated plants, and even in the operation of electrochemical processes, as well as in the increase of motor loads.

If electric rates are to vary with the cost of rendering the service, it is of interest to know how a consumer who contributes to the short hours of nearly maximum load is to escape the highest rate for energy received at such times.

Coming to the electric supply systems under consideration, the data concerning them are arranged in the accompanying table, according to the number of kilowatts in the average 24-hour load. This average is obtained by a division of 8760, the number of hours per year, into the total number of kilowatt-hours generated. Besides the average load, the maximum load of the year, the percentage of the average to this maximum, and the kilowatts of generator capacity are given for each plant.

Though the tabulation covers a wide range from the average load of 10,374 kw down to only 66 kw, there is a striking approach to uniformity in most of the percentages of average to maximum loads.

No definite variation of the percentage of average to maximum load is to be noted with the size of plant, and it happens that both the lowest and the highest percentage is found among the stations of rather small outputs. The general

force of these percentages is to show that the annual outputs generated by the electric stations are equivalent to continuous operation at one-fifth to one-third of the maximum loads.

The selected stations cover a range of maximum load from 36,324 kw down to 224 kw, and so represent the character of the demands on electric supply systems from great cities to small towns.

The generator capacities in these electric systems run from 61,400 kw in the largest down to 222 kw in the least.

Wide differences will be noted in the proportions of generator capacities to maximum loads. In more than one-half of the systems, however, the capacities of the generators were 1.3 to 1.7 times the maximum loads. These varying ratios for generator capacities must be attributed to additions of new equipment as well as to the requirements for reliability and for inductive alternating loads.

Water power was used to generate important parts of the outputs in the system that had an average load of 1893 kw and in that with 336 kw, while water power did most of the work for the average load of 75 kw. These three systems show percentages of 33.2, 25.3 and 33.6 respectively for the ratios of the average to maximum loads. As two of the percentages last named are the largest in the list they appear to confirm the general impression that the use of water power tends to develop a high load factor. In this connection, however, it may be noted that in many instances water power has merely served to develop a large motor load without much addition of electric heating and residence lighting. Where this has been the result the load factor may have changed but little with a large increase of average load, unless the use of motors is so restricted that the power load is not added to the lighting peak on winter days.

In the supply system where the load factor was only 25.3 per cent in spite of the extensive use of water power, more than one-half of the total output was sold to an electric railway, and nearly twice as much of the remaining energy was sold for stationary motive power as for lamps. With these railway and motor loads added to the lighting peak a high power factor could not be expected.

At the plant with the load factor of 33.6 no energy was sold to electric railways, and the sales of energy for motors amounted to 1.6 times the sales for lamps. The load factor of 33.2 per cent for the next to the largest system in the group is of especial interest from the fact that the generating capacity of the water power, though only about one-half as great as that of the steam power equipment, was utilized to develop a large lighting as well as a large power output. In spite of its connected load of more than six thousand horsepower in motors, this system sold more energy for light than for power during the year. The equivalent lighting load in this system was about 130,000 lamps of 16 cp each. A great variety of manufactures were carried on in the service area of this electric system, that of machinery being the leader, but these manufactures were not mainly of the sort that request the largest amounts of power.

What can be done by an electric system having steam for its only source of power in a city of heavy manufacturing loads is shown by the load factor of 32.7 per cent with the average load of 1146 kw. In this instance the combined rating of connected motors was over 6000 hp and the lighting load was equivalent to about 80,000 lamps of 16 cp, but the sale of energy for power was nearly twice as great as the sale for light. Textile industries were the great users of energy in the city served by this electric system, and motors connected with the public supply did a good share of the work.

The load factor of 32.6 per cent with the average of 538 kilowatts was secured by the combination of large street and residence lighting and motor loads in a territory where there was comparatively little store lighting. In this system more than one-fourth of the total output was devoted to street lighting, and with more than 1200 hp of connected motors the lighting load exceeded the equipment of 90,000 16 cp lamps.

Quite a different situation in the system with 22.1 per cent load factor and 244 kilowatts average illustrates the proposition that a large motor load when unrestricted as to time may do very little to decrease the relative importance of the lighting peak. This system had motors connected to a combined rating of more than 1600 hp and sold about twice as much energy for motors as for lighting, but still its load factor was near the lowest in the list. Evidently something besides 10-hour motor service is required to even up the load curves of central stations.

MAXIMUM AND AVERAGE LOADS.

Kw Average Load.	Kw Maximum Load.	Per Cent Average to Maximum.	Kw Generator Capacity.	Ratio Generator Capacity to Max. Load
10,374	36,324	28.5	61,400	1.7
1,893	5,693	33.2	9,625	1.7
1,146	3,492	32.7	4,900	1.4
1,004	3,350	30.0	5,290	1.6
740	2,735	27.0	4,700	1.7
668	2,510	26.6	4,505	1.8
538	1,650	32.6	3,650	2.2
482	1,850	26.0	2,500	1.3
457	1,510	30.2	2,000	1.3
424	1,675	25.3	2,300	1.3
354	1,245	28.4	2,700	2.1
336	1,325	25.3	2,100	1.6
291	980	29.7	1,570	1.6
244	1,100	22.1	1,839	1.6
219	710	30.8	2,300	3.2
149	523	28.4	600	1.1
135	650	20.7	1,195	1.8
125	500	25.0	725	1.4
75	224	33.6	222	1.0
66	308	21.4	340	1.1

For the metropolitan system where short-hour lighting is in great demand, with its average load of 10,374 kw, perhaps the most notable fact is that a load factor of 28.5 per cent was obtained with only about 12 per cent of the total output devoted to street lighing, and with the equivalent of nearly one million 16 cp lamps and more than 44,000 hp of motors connected.

Central Station

Management, Policies and Commercial Methods

ENERGY CONSUMPTION IN HOT SPRINGS, ARK.

The electrical department of the Hot Springs (Ark.) Water Company, which supplies electricity to the town, finds that the total accounted-for consumption of its 2000 customers, whose use of electrical energy is at the rate of about 200,000 kw-hours per month, was for 1909, 80.4 per cent of the total amount generated, as indicated by the station switchboard meters. The figure for the quantity consumed by customers includes the estimated consumption of 12 flat-rate customers still supplied on this basis, the amount being, of course, a very small faction—less than ½ per cent—of that taken by the other 200 consumers.

The utility figure for 1908 shows energy sales of 75.05 per cent of that generated, the 5 per cent improvement being attributable to the increased number of meters installed and general rehabilitation of the system. Mr. E. A. Main is electrical superintendent.

FIRELESS COOKERS.

At the Nebraska Electrical Association convention at Lincoln, May 5, Mr. J. D. A. Cross, in answer to some questions on the convention floor as to the work being done in the direction

of employing the principle of fireless cookers, said that many experiments had been made with them, and that there will soon be placed on the market an electric cooker operating on the heat-storage principle, whereby a small amount of electrical power will be taken 24 hours a day, thus making the maximum demand so low that the cooker can be operated from ordinary lighting circuits. A cooker for all purposes would require a maximum of 2500 watts.

IRONING-DAY ELECTRIC SERVICE.

The small station contemplating 24-hour service might consider the advantages of first taking up a special ironing-day service, operating one or more days or afternoons out of the week, to supply customers' electric irons. In the experience of Holdenville, Okla., which for several months gave Tuesday and Wednesday afternoon service, although doubtful about the results of straight 24-hour operation, it was possible to interest 50 out of 125 residence consumers in the 2-day ironing-service proposition, and to sell them irons at full price. Of the first 50 irons thus placed on trial, about 10 were returned, but afterward successfully placed. The appreciation of this afternoon ironing service became such that for this, and other reasons, the company soon began regular 24-hour service, and has since added 50 more electric irons on its lines.

HOUSE MOVERS MUST NOT INTERFERE WITH ELECTRIC WIRES.

The Edison Electric Light & Power Company, of St. Paul, brought an action against a party engaged in moving a house to restrain him from interfering with the company's wires. The house mover had obtained a permit to do the work from the city, which contained this restriction: "This permit does not allow interference with wires or any other obstruction on above route." The company obtained an injunction which restrained the house mover from adjusting or interfering with any of the company's wires, without giving the company 24 hours' notice in writing, so that the company might have an opportunity to remove the wires. The house mover was also required to file a bond indemnifying the company for any expense connected with the adjustment of its wires.

COST OF MUNICIPAL OWNERSHIP AT FAIRVIEW, OKLA.

Eighteen months of operation of the municipal electric-light and water plant at Fairview, Okla., has cost the taxpayers about $5,000, reports the Mayor, Mr. P. H. Wimpey. The electric-light plant is of 100-kw capacity and supplies about 125 customers, who receive a sliding-scale rate of 15 to 10 cents per kw-hour. Several special rates have been made by previous city councils to favored large consumers, one customer having a five-year contract for energy at 1.5 cents per kw-hour, although the figures for the operating costs alone (on which the estimate was made) showed this amount to be far below the production costs. The deficit on the plant for the present year has been $3,500, and a special tax of $6,000 has had to be levied on the citizens to meet the cost of running the station.

Mr. Wimpey advises that the authorities of any community contemplating municipal-plant operation should inform themselves of the facts before undertaking the running of such a station.

AN ELECTRIC IRON WITH YOUR NEWSPAPER.

The Muskogee Gas & Electric Company, of Muskogee, Okla., has entered into an agreement with a local daily newspaper by which as a special premium offer, an electric iron (sale price, $4), is given with an annual subscription to the paper at the regular rate of $4. The nominal loss in selling price is shared equally by the company and the newspaper, each accepting $2 of the customer's $4 payment as payment in full of its share for material furnished. While the central-station company thus loses the difference between $2 and the actual net cost of the iron, it believes that the addition of this energy-consuming device to its lines will soon repay this deficit, after which the iron becomes a revenue producer. The circulation department of the newspaper is doing all the pushing of the proposition through its solicitors, who make house-to-house calls. No public announcement of the offer has been made through the columns of the paper itself. Gratifying results have been obtained during the 30 days the solicitors have been making the electric-iron offer.

AN ELECTRIC IRON FOR EACH CONSUMER.

Fayetteville, Okla., with a population of 8000, has 512 connected residence customers and 502 electric irons installed. According to the local manager, Mr. J. W. McLinden, out of the entire number of these irons, which were placed on a 30-day trial proposition, by various methods of house-to-house canvassing, use of an iron wagon and by personal solicitation, only four were returned. All irons are maintained in repair by the central-station company for 12 months after the date of sale. The rate for residence and commercial lighting is figured on a sliding scale, diminishing from 15 cents to 6½ cents per kw-hour, according to the amount consumed.

The Fayetteville company also serves several laundries, one of which is entirely electrically operated and heated. For strictly non-peak business there is a rate of 5 cents per kw-hour for energy used in motors. As the work in the laundries is frequently overtime, two separate meters have been installed for reading daylight and night consumption respectively. These are fitted with a time-switch which automatically changes from one circuit to the other. The distinction between the two rates and readings has been found an important one in the case of the Fayetteville company, as the income from the overtime business at the higher regular rate frequently exceeds that of the ordinary working-day consumption.

An even better showing is made in Huntington, Ind., where there are 1248 residence customers, and 1228 electric irons installed. These facts came out recently when an iron manufacturer received an order for 20 irons. When he inquired whether a standard full box of 24 would be acceptable, the answer obtained was to the effect that the number first requested would just exactly stock up the remaining consumers, to whom the chances seemed good for selling the irons.

MINOR STREET-LIGHTING AT BOSTON.

The Boston Finance Commission has transmitted a report to Mayor Fitzgerald upon the question of lighting minor thoroughfares, in connection with the awarding of a new contract for this service. The existing contract with the Rising Sun Street Lighting Company expires on July 31, and as the company owns the lanterns and has submitted a bid which the commission feels is too high, $23.60 per lamp per year, with little prospect of lower figures, the report states that the city is at a disadvantage under the present arrangement. The commission recommends, in the absence of a lower bid from the Rising Sun company, that the city appropriate $175,000 to equip 12,000 lamps, and accept the offer of the Boston Consolidated Gas Company to furnish gas at $20.51 per lamp per year, as made in July, 1909. If favorable terms cannot be secured from either of the above companies the commission recommends that the existing contract with the Edison Electric Illuminating Company be extended so as to provide for the installation of 5000 tungsten lamps in parts of the city served by underground wires. The rate for these lamps would be $22.31 per lamp per year. The commission takes a rather timid view of the situation in a portion of its report, which objects to the substitution of electric lamps for the entire 12,000 existing gas lamps on the ground

that serious consequences might result from a monopoly of the lighting and that storms would endanger the permanency of service of lamps fed by overhead lines. It is probable that in due time the benefits of the tungsten lamp as compared with the fluctuating street Welsbach will be appreciated in Boston to an extent which will drive gas lamps off all streets provided with underground conduits. The lighting of Boston's main thoroughfares by electricity has reached a standard so far ahead of anything possible with gas at commercial prices that public sentiment will almost inevitably demand a corresponding improvement on the side streets.

FOUR HUNDRED CONTRACTS A DAY.

The month of April, 1910, was the most successful month in the history of the business of the Commonwealth Edison Company of Chicago, so far as the number of individual orders is concerned. The total number of new contracts received during the month was 10,398, which may be compared with 8466, the corresponding total for the month of April, 1909. Of the 10,398 new contracts entered 6200 were for new business and 4196 for "successors." The average was about 400 for each working day. Of these, an average of 107 a day was taken over the counter at headquarters at 139 Adams Street; the remainder was received from agents. To handle this large volume of business it was necessary to employ a night force of clerks not only in the contract department itself, but also in the credit department, inspection department, meter department and repair department.

The heaviest day's business during the month was on April 29 when 644 new contracts were entered. At the main office the greatest rush came at noon time, and to help over this "peak" six assistant agents were called in to help the countermen during the noon-time rush. Three of these men were on duty for one hour and three for the succeeding hour. During the remainder of the day the duties of these assistant agents consisted in helping the agents on the street. In 12 working days at the close of the month 5238 orders for changes of address were issued. This included cut-offs as well as changes from one address to another.

Of course, the business of the company is especially heavy during the moving season, about May 1 and Oct. 1. The clerks of the contract department are of the opinion that the spring moving season is being spread out considerably, as the rush of business began this year on March 15 or before. It may be considered to last from March 15 to May 15 in the spring, while the corresponding fall season may be said to be from Sept. 1 to Oct. 15.

RESPONSIBILITY FOR DEFECTIVE CROSS-ARM

The Court of Appeals of Maryland has decided that an electric light and power company is not liable for injuries to a lineman in the employ of another company caused by the breaking a cross-arm where the cross-arm was not defective when originally placed in position, nor is the company by which the lineman was employed liable in such a case. If an electric company has, to the knowledge of its lineman, a regular system of inspection of the poles and cross-arms, independent of what the linemen themselves would be supposed to make, the linemen would have the right to assume that the independent inspection had been made; but when the employer has no independent system of inspection of poles, cross-arms, steps, etc., and the lineman has no reason to believe that such inspection is made, he has no right to rely on the employer for such inspection, but must make such tests himself as may be necessary to ascertain whether it is safe to go upon them, and cannot hold the employer responsible for injuries received by him by such poles, cross-arms, or steps giving way, unless there was some defect in them when they were originally placed in position, or the employer had some knowledge of the defect, which was not communicated to the lineman; provided, of course, the lineman is not such an inexperienced person as is entitled to be instructed as to the danger. There is more reason to apply such a rule to cross-arms than to poles, for there are usually so many more of them, and, as said in one case, inspectors "were not expected to climb up every pole and examine the arms thereon. Such an inspection would be manifestly impracticable and unnecessary." It is, in fact, far safer for the linemen themselves to make the inspection and such tests as may be necessary for their safety, as they would do so at the very time they went upon them, while in many instances that would be impossible if separate inspectors were relied on. This doctrine is not in conflict with the one that the master must furnish a reasonably safe place for his servant to work in, as that is always subject to the qualification that, when a servant knowingly engages in dangerous work, he must not rely alone on such rule, but he assumes the risk incident to the work. Consolidated Gas, Electric Light & Power Company vs. Chambers, Court of Appeal of Maryland, 75 Att. Rep 241.

CENTRAL-STATION RATES IN NEBRASKA.

Mr. B. L. Smith, of Nelson, Neb., presented at the Nebraska Electrical Association convention at Lincoln, May 5, a compilation of rates of small central stations in that state. He had reports from 20 stations in towns of less than 5000 inhabitants. The average maximum rate of the companies reporting was 14.6 cents per kw-hour. West Point, Neb., has a 15-cent rate with discount according to quantity. Superior, Neb., has a 15-cent uniform rate. St. Paul has a 17-cent rate. At Aurora the rate is 15 cents, with a discount on quantity. At Edgar flat rates prevail. At Gothenburg the rate is 10 cents per kw-hour. At Humboldt the rate is 12 cents, with a discount on the average consumption per month per given amount of connected load. Albion has an 18-cent rate with a discount on quantity. At Howard the rate is 15 cents with a discount on quantity. At Neligh the rate is 10 cents with a discount for quantity. At Geneva the rate is 16 cents with a discount for quantity.

Mr. G. S. Sprague, discussing this report, said that he did not believe in a rate which gives a discount on quantity only. He thinks the discount should be on the quantity consumed per month per lamp connected. Mr. Sprague said that he is pumping water for the city at 4 cents per kw-hour, which is practically the same as it has cost the city for the past five years to pump with steam. Mr. Bell, of David City, said that his company formerly had a rate based on the number of hours' use of the connected load, and later changed it to a straight discount on quantity. Mr. Bullock, of Norfolk, said that the man who will use one lamp from midnight to dusk is entitled to the lowest rate given by the company. The next lowest rate should be given to the man who uses energy 24 hours per day. Nevertheless, it may be expedient to offer some of the lowest rates to shorter-hour customers. He is thinking of adopting the two-rate system in use in Omaha, basing his discount on the number of hours' use of the connected load per month. Mr. MacMaster, of Beatrice, said that he had in force the two-rate system, charging 13.5 for the primary portion of the bill and 6 cents for all coming under the secondary portion. The primary rate is charged until the consumer has used his connected load a certain number of hours.

CENTRAL-STATION GROWTH AT MUSKOGEE, OKLA.

As the result of the rapid increase in its lighting load, the Muskogee Gas & Electric Company, Muskogee, Okla., is rebuilding its generating station and adding a 1500-kw, alternating-current generator to its present capacity of 1000 kw in alternator equipment. A new brick-and-steel generator room (111 ft. x 60 ft.) and boiler-room (111 ft. x 53 ft.) are being erected. The new equipment comprises a 1500-kw, General Electric, 2300-volt, 60-cycle, three-phase alternator driven by an Allis-Chalmers compound Corliss engine; two new 520-hp Babcock & Wilcox boilers equipped for gas and oil burning; a

175-ft. concrete stack, and a Kennicott water-softening plant having a capacity for treating 48,000 gal. per day. The new station structure provides for a future 3000-kw unit, and may later even be extended to include other machines. The plant has direct pipe-line connection with an oil refinery in the important Muskogee oil field, about a mile away. The oil costs 50 cents a gallon. The natural gas is piped 85 miles, and costs 5 cents per 1000 cu. ft. The present total connected commercial load of the station is 1800 kw, of which about one-half is in three-phase motors. In addition to its nominal 1000 kw in alternating-current machinery, which has been taxed above this rating to carry the present load, the station includes two 300-kw, 530-volt, direct-current railway generators whose output is taken by the local traction company for its street cars. The electric company also transmits energy at 6600 volts to Ft. Gibson, Okla., nine miles distant, replacing, with 300 kw in transformers, the service formerly rendered by a producer plant which was destroyed by fire. The Muskogee city lighting contract includes 259 arc lamps. The present census will probably show Muskogee to have a population of about 36,000. It is a modern wide-awake city which uses a relatively large amount of electricity for signs and display lighting.

A successful basis for the local large sign business is the offer made by the lighting company, which will install signs complete, and maintain and light them from dusk to midnight, for 18 cents per month for each 2-cp carbon lamp, and 20 cents per month for each 4-cp tungsten lamp, the customer signing a two-year contract agreement. Where the customer furnishes his own sign, 12 cents per lamp per month is charged. The Muskogee Gas & Electric Company is operated by H. M. Byllesby & Company, Chicago. Mr. H. C. Hoagland is local manager.

AN EFFECTIVE RESORT IN GASOLINE LIGHTING COMPETITION.

The electric-light man in competition with other kinds of illumination is at the disadvantage that he cannot tender his product for the customer's examination in the same way the salesman of tangible commodities shows his goods and samples. Mr. T. B. Martin, of the Waurika, Okla., Electric Company, has found the battle of replacing gasoline lighting outfits by tungsten lamps to be more than half won, by securing permission from the store or shop owner to let electric lamps be installed on a fair proposition which gives the customer a chance to see for himself.

The wiring and lamps are installed under the condition that if accepted after 60 days' trial the customer will pay for the installation at cost, and for the energy consumed at the regular rates. If he does not accept the electric light after this trial, the electric company will then remove all its wiring, and no charge will be made for the energy used.

In every one of a number of cases where this plan has been adopted in Waureka, the consumer has selected the electric lamps, and thus justified the investment of the electric company. Of course, one or two customers have been slow in giving their approval, claiming that even in spite of the superior satisfaction of the electric light they could not well afford to tear out and "junk" a comparatively new gasoline-lighting system. Instead of removing the wiring and fixtures promptly, in these cases the electric company usually found it convenient to keep its wiremen too busy somewhere else, explaining to the reluctant customer that until "they got around to it," he might use the electric lamps at the regular rate, paying for what he consumed.

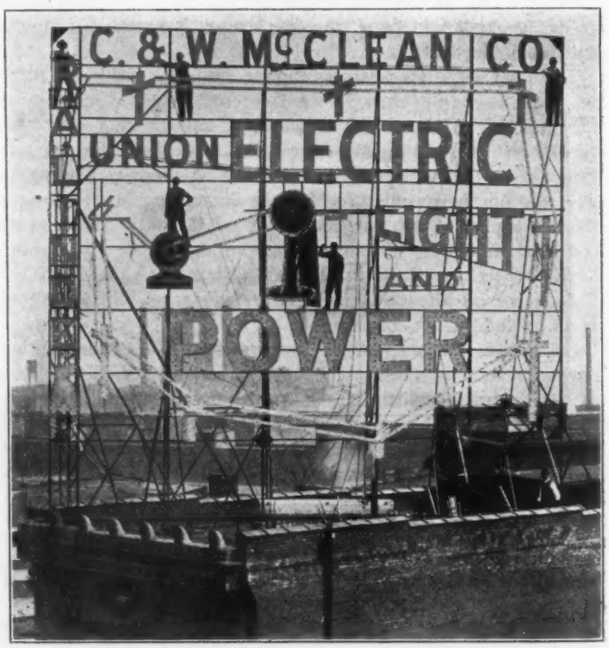
The next ally of the electric company then usually proved to be the gasoline-lighting system itself, which without warning would fail to work, and thus give the customer renewed evidence of the reliability and excellence of electric lighting. One or two trials like this have been sufficient to bring the most reluctant customer into line.

To customers who plead the higher cost of electric lighting, over gasoline, a proposition is made for the alternate use of the two systems on successive days. This also shows the comparative satisfaction of the two methods. The inexperienced consumer tends to the idea that his gasoline costs him less than electricity, and fails to consider the cost of mantles and extra insurance, nor the increased safety and comfort. Again while the consumer's electric meter affords him an accurate total of his energy consumption, he is especially liable to forget purchases of gasoline bought in small quantities, and thus to underrate the latter consumption.

SPECTACULAR CENTRAL-STATION SIGN IN ST. LOUIS.

Probably the majority of central-station companies use some kind of electric signs for their own advertising, with considerable success. In some of these signs ingenious spectacular features have been introduced, although, like the shoemaker and the blacksmith of the proverb, the average electric-light company contents itself with supplying energy for the clever moving displays of its customers in other fields, and does not realize the possibilities of flashed signs advertising its own wares.

A striking spectacular sign advertising light and power service has just been erected by the Union Electric Light & Power Company, of St. Louis, Mo., on the roof of a building at the turn of Broadway, near Morgan Street, where it commands a



Spectacular Sign in St. Louis.

view of about 20 blocks of the former main thoroughfare. The spectacular features of the display depict, somewhat fantastically, of course, the electrical energy coursing over a transmission line and operating a motor-driven emery wheel against which a bar of iron is seen to be fed with an attendant display of bright sparks. When the lights first come on, only the poles are seen outlined in red. Then, as the flow of electricity is supposed to start, the line wires light up with a rapid progressive motion, in skyrocket fashion, encircling the sign, until the switch at the left is reached. This is then seen to throw in and the motor, belt and emery wheel are shown in motion by means of flasher devices. Next the iron bar at the right is seen to move against the emery wheel, by an arrangement of lamps, and a series of sparks fly off from the point of contact, first white, the number, and finally dying out to red at the extremities of their paths. Meanwhile, by means of a ripple effect, the "flow of energy" in the wires is seen, encircling the sign and entering the motor. The words "Union Electric Light and Power" next appear and remain a few seconds after

the moving display has been extinguished. The other names appearing on the sign are those of merchants in the building below and that adjoining, whose good will it was necessary to obtain in order to erect the sign. The company whose name appears at the top of the sign, was prevailed upon to remove its obstructing sign from the next building, in order to make this display visible, as this particular situation is probably the most conspicuous one in St. Louis for an electric sign.

This spectacular sign contains nearly 2000 4-cp carbon lamps, of various colors. The sign itself measures 41 ft. × 43 ft. and the steel work used in its construction weighs about 1000 lb. An idea of its size is gained from the accompanying daylight picture which shows the men completing the construction. All wiring is in conduit, and the lamp sockets are enclosed in waterproof tin boxes forming the letters and signs. The operation of the sign is controlled from a large flasher having 51 contact rings besides the sign switches. This flasher is driven by a ⅛-hp motor, and is enclosed in a weatherproof metal box 11 ft. x 2 ft. x 3 ft., mounted on the roof. Four contacts are required for the sparks, 6 for the rotating devices, 12 for the ripple flow, 2 for the switch, 21 for the run of the pole line, and 12 switches for the main circuits and signs. The difficulties of guying a large sign of this kind on the roof of an isolated narrow building were solved by erecting latticed bridge structures supported by struts, from which the sign is braced. The sign is a prominent spectacle from any point of the downtown business section of Broadway, and has occasioned the liveliest interest of passers-by. This sign was constructed and erected for the Union Electric Light & Power Company by the Brilliant Sign Company, of St. Louis.

THE DETERMINATION OF RATES FOR ENERGY.

At the Iowa Electrical Association convention, on April 21, a discussion of the subject of rates was opened with the presentation of a paper by Mr. J. R. Cravath, who reviewed briefly the general principles of rate-making which are now finding general acceptance among those who have studied the subject, and followed this with a review of some of the principal decisions of State public service commissions recently pertaining to rates.

He said it is now generally accepted that any rate for electric service should be made up of two factors or elements: (*a*) the fixed charges, including interest on the investment, depreciation, insurance and taxes; and (*b*) the variable charge for operating expenses which depend on the kw-hour output. There are various methods of determining the rates. The most common method is to charge a high rate per kw-hour for a certain number of hours' use per month of the connected load, and a lower rate for the kw-hour consumption after that. Another method, commonly called the "Doherty system," has a readiness-to-serve charge proportionate to the consumer's connected load, made up without regard to the kw-hour consumption. To this is added a low operating charge per kw-hour consumed.

Taking up the matter of commission decisions sustaining the principles set forth, the author mentioned first that the Edison Electric Illuminating Company of Boston has for many years employed a system according to which a high rate per kw-hour is charged until the fixed charges connected with the consumer's installation are paid, after which the cost is much lower. These rates have for years been necessarily subject to review or revision by the Massachusetts Gas & Electric Light Commission and have also been investigated by expert arbitrators with the result that the principles involved have always been sustained.

One of the first and most important cases to be decided in Wisconsin involved the rates of the central station at La Crosse. There had previously been a cut-throat competition between two companies. After the consolidation of these companies permission was asked to raise the rates to a point where the company could live. After investigating the matter the commission decided in favor of an increase in rates, the scheme of charging to be practically what is known as the Doherty readiness-to-serve system.

The most important decision of the year in Wisconsin was one recently rendered in the Madison Gas & Electric Company case involving the careful investigation and valuation of the company's property, both tangible and intangible. It involved a decision as to what constituted a proper rate of return on the investment for corporations supplying public service under conditions such as existed in Madison. The commission considered that 8 per cent was a reasonable rate of return on the electric plant. The schedule of lighting rates ordered by the commission was 14 cents per kw-hour for the first 30 hours' use per month of the active connected load, 8.5 cents for the next 60 hours' use and 5 cents for all excess over 90 hours' use. For residences, 60 per cent of the connected load is deemed active where the total connected load is less than 500 watts and one-third of all over 500 watts is considered active. In business and industrial plants 70 per cent is considered active, while in churches, public buildings, hotels, schools and small industrial establishments, 55 per cent is considered active. The minimum bill for motor users is $1.50 and for lighting consumers $1.

Another case recently decided in Wisconsin was a readjustment of the rates of the Ripon Light & Water Company. In this instance the change will not materially affect the company's gross revenue, but will distribute the cost of rendering service more equitably among its consumers. The cost of service was found by the commission to be 16.88 cents per kilowatt for one hour's operation per day, 13.07 cents for two hours' operation and 11.79 cents for three hours' operation. The rates ordered were 17.75 cents per kw-hour for energy used equivalent to or less than the first 60 hours' use per month of the active connected load and 9 cents for energy used in excess of 60 hours per month of the active connected load. The minimum bill is 75 cents. Public buildings and residences are considered 40 per cent active; schools, churches and industrial plants closing before 6 p. m., 55 per cent active; livery stables, hotels, etc., 60 per cent active; stores, offices, banks and saloons, 79 per cent active; signs, 100 per cent active.

In addition to these decisions the author cited the report made to the Chicago City Council on the rates of the Chicago central-station companies in 1906 by Messrs. B. J. Arnold and William Carroll. He also cited a report made by Mr Charles L. Pillsbury, consulting engineer, Minneapolis, to Hon. B. F. Nelson, chairman of the Citizens' Committee, which are along the same line. To determine the fixed investment charges which should be carried by any such class of business, it is of great importance to know the relation which this business has to the peak load of the generating station. The most thorough results yet published on this subject, he said, were given by Mr. H. B. Gear, one of the engineers of the Commonwealth Edison Company, of Chicago, at a joint meeting of the Western Society of Engineers and American Institute of Electrical Engineers at Chicago, on March 23. Mr. Gear found under Chicago conditions that for residence business in which the sum of the consumers' maximum demands during the heaviest month of the year is 100 kw, 16 kw of substation equipment would be required. For commercial lighting 43.5 kw would be required and for scattered motor load, 39.5 kw. The peaks for these different classes of business were not, however, coincident.

In conclusion Mr. Cravath cited a Massachusetts commission decision made recently which has considerable bearing on the question of rates. This decision was to the effect that a company should not pay for extensions and enlargements of its plant out of net earnings. The commission took the position that when such additional investment is made it should be represented by increased equipment. This decision, he said, is evidently for the purpose of preventing confusion as to the net earnings of the company and the amount invested in the plant, to the end that decisions can more readily be reached as to whether the rates should be reduced.

In discussing the paper Mr. George S. Carson said that the decisions cited show that the establishment of a State commission is necessary if companies are to receive fair treatment. He deplored the tendency among central-station managers to discriminate between their customers, and to decrease a consumer's bill simply because it is large.

Mr. Austin Burt remarked that in many cases the manager of the small plant has so many bookkeeping and lineman's duties to perform that he never has time to consider the best methods of conducting the business or to learn what the plant is really doing. He advanced the proposition that any plant that cannot support a stenographer and a lineman to relieve the manager of these duties cannot do a paying business.

Mr. C. D. Jones stated that it had been the policy of his company to pay for extensions out of earnings instead of paying the earnings in dividends. Now that a franchise controversy is on, people are claiming that the company is not entitled to the value of these extensions because the people pay for them. He therefore thought that the policy of capitalizing extensions is the best from a bookkeeping standpoint if from no other.

Prof. A. H. Ford pointed out that some charges will vary with the number of customers. In certain plants these charges, such as bookkeeping, meter reading, etc., amount to $12 per year per meter.

Mr. E. A. Bullock showed that it is not always a question of how much the company can charge under its franchise, but how much it can get for its service in competition. Many members of the Nebraska Association have much desired a commission in that State and a bill was before the last Legislature which nearly reached passage, but a furore was raised by certain newspapers that the power of home rule was being grabbed away from the city councils and hence the bill did not pass.

Mr. Bellamy expressed himself as being in favor of the commission plan. His company has found that on outside overhead construction the depreciation is 15 per cent. The depreciation on inside apparatus is from 6 to 7 per cent.

Mr. J. P. Walters thought it an error in bookkeeping for a company to mix the cost of extensions to plant in with other expenses. Many companies are making such errors.

Mr. George Carson pointed out that the rate should not be a question of what other plants are doing but of its application to local conditions. If the company adopts the two-rate system, such as was outlined in the Wisconsin Commission decisions quoted, it can go into the courts and show that such a rate varies equitably according to the cost of production. On the other hand, a rate which is made low simply for quantity consumed, is not right or equitable.

COST OF ENERGY FOR TEXTILE MILLS.

In a paper by Mr. Charles T. Main, presented at the Boston meeting of the National Association of Cotton Manufacturers, April 27 and 28, it was stated that the cost of energy in a textile mill seldom exceeds 5 per cent. of the total cost of product, and that locating with respect to labor and transportation requirements is more important than finding a situation where energy is cheap.

The principal items affecting the cost of energy are the cost of fuel delivered to the boilers, the amount of energy produced, the fixed charges on the cost of the plant, and the cost of attendance and supplies. The net cost is reduced in cases where the waste heat can be used in the manufacturing or heating processes. In textile mills the power plant will vary in rating from 1000 to 5000 kw. The cost of installation will vary in general from $125 per kw in the 1000-kw plant, to $90 in the larger plant, and the coal consumption may be expected to run from 3.0 to 2.5 lbs. per kw-hour. The cost per kw-year, with coal at $5, would vary from $39 in the smaller plant to $29.50 in the larger one. With coal at $5 per ton, if 25 per cent. of the steam is used after being exhausted, the cost of energy production would be reduced by about $3.50 per kw-year; if 50 per cent. of the steam is thus used the cost would be reduced by about $7; if 75 per cent., $10.75, and if all the exhaust is used, the cost would be cut down by $14.25. With coal at $4 per ton, the reduction in the cost per kw-year would be $2.80, $5.60, $8.60 and $11.40, respectively. The yearly cost of energy in the 1000-kw plant would be about $35 per kw-year with coal at $4, and $26.25 with the 5000-kw station.

In estimating the cost of energy Mr. Main considered all charges except interest and taxes on the cost of land. The fixed charges, including depreciation, repairs, insurance and taxes were assumed at 11 per cent, and the running time 2900 hours per year. Two steam turbines were assumed in each plant.

Passing to hydroelectric energy the author gave an interesting table of the cost of producing electricity at the switchboard for uniform service for various sizes of plant at assumed development costs of from $100 to $300 per kilowatt.

TABLE I.—COST OF UNIFORM ELECTRIC SERVICE.

Size of Plant in kw.....	1000	2000	3000	4000	5000
Assumed cost per kw.....	$100	$100	$100	$100	$100
Yearly cost per kw.....	12	11	10.75	10.50	10.25
Cost per kw-hour in cents...	0.41	0.38	0.37	0.36	0.35
Assumed cost per kw.....	$200	$200	$200	$200	$200
Yearly cost per kw.....	21	20	19.75	19.50	19.25
Cost per kw-hour in cents...	0.73	0.69	0.68	0.67	0.66
Assumed cost per kw.....	$300	$300	$300	$300	$300
Yearly cost per kw.....	30	29	28.75	28.50	28.25
Cost per kw-hour in cents...	1.05	1.01	1.00	0.99	0.98

The cost of delivering energy at the end of a long line would be about 10 per cent more than the above, and for a short line 5 per cent.

Mr. Main also presented a table showing the cost of energy with variable power at the switchboard of the generating station, with a hydroelectric plant costing $100 per kilowatt, and with coal at $3 per ton, to show the result of auxiliary steam-plant operation.

TABLE II.—COST OF ENERGY USING STEAM AUXILIARY SERVICE.

Size of Plant in kw	Cost of Hydro-electric Energy per yr.	Fixed Charges Steam Plant	Total Cost When Steam Plant is Run for Following Number of Months				
			One	Two	Three	Four	Five
1000	$12.00	$11.00	$25.50	$28.00	$30.50	$33.00	$35.50
2000	11.00	11.00	24.50	27.00	29.50	32.00	34.50
3000	10.75	11.00	24.25	26.75	29.25	31.75	34.25
4000	10.50	11.00	24.00	26.50	29.00	31.50	34.00
5000	10.25	11.00	23.75	26.25	28.75	31.25	33.75

With transmission losses at 10 per cent a hydroelectric development producing uniform power should cost not over $300 per kilowatt total to compete with a steam plant at the mill with coal at $5 per ton, except for small plants; with coal at $4 the hydroelectric development should cost not over $250, on the assumption that the steam plant produces only electrical energy, there being no further uses for steam. With a hydroelectric development having a variable power requiring auxiliary service, and with coal at $5 per ton, the cost of the hydroelectric plant should not exceed $250 in a 1000-kw installation with one month's auxiliary operation, and $150 with five months' auxiliary service. With coal at $4 the figures would be $200 per kilowatt at one month's auxiliary service, and $100 for five months' operation. For a 5000-kw hydroelectric plant and coal at $4 the initial cost would have to be $125 per kilowatt on one month of auxiliary service and $25 on five months. These figures apply to secondary power. The effect of the use of exhaust steam on the hydroelectric plant is to reduce the amount which can profitably be invested in the development by about $40 per kilowatt for each 25 per cent of steam thus used with coal at $5 and by $30 where coal is at $4; so that if 100 per cent of the exhaust could be used, the maximum economical sum to put into the hydroelectric development would be about $150 in a 1000-kw plant with $5 coal, and $125 with $4 coal.

In conclusion the author discussed the advantages of purchasing energy from a central station or transmission company. Such a course means a smaller initial investment, a saving in space, possibly a better arrangement of buildings, removal of some care of the power plant from the management, and postponement of the introduction of an isolated plant. He stated that in a plain mill making no use of exhaust steam, for guar-

anteed power it will be profitable to pay 1 cent per kw-hour for 5000 kw, or 1.33 cents for 1000 kw, with coal at $5, and about 0.9 to 1.25 cents per kw-hour with coal at $4. In a colored mill, using all the exhaust steam the management could afford to pay from 0.4 to 0.5 cent less per kw-hour with $5 coal, or from 0.3 to 0.4 cent less with $4 coal.

CENTRAL-STATION RATES IN NEW YORK AND BROOKLYN.

In an appendix to its annual report for 1909, the New York Public Service Commission, First District, gives the following rates for electrical service in New York City and Brooklyn:

NEW YORK CITY.

The New York Edison Company's and the United Electric Light & Power Company's schedules of rates, as filed with the Public Service Commission for the First District, are as follows:

Retail Service.—Lighting, 10 cents per kw-hour; power, 10 cents per kw-hour for the first 200 kw-hours of monthly consumption; from 200 to 400, 8 cents; from 400 to 3500, 6 cents; from 3500 to 7000, 5 cents; all over 7000, 4 cents.

Intermediate Wholesale Rate.—This rate is based upon a guaranteed consumption of 2000 kw-hours monthly for 10 months in the year, and that during such months the average use of the total equipment shall not be less than two hours daily. In consideration of these guarantees, the rates charged are: for the first hour of average daily use of the entire installation, 10 cents per kw-hour; for the second hour, 9 cents; for the third hour, 8 cents; for the fourth hour, 6 cents; for the fifth to fourteenth hour, inclusive, 5 cents; above 14 hours, 4½ cents. If the monthly use should exceed 5000 kw hours, a reduction of 5 per cent will be made in the amount of the monthly bill; if it should exceed 10,000 kw-hours, a reduction of 10 per cent will be made. If the consumer supplies his own incandescent lamps, a reduction of ½ cent per kw-hour will be made.

Special Wholesale Rate.—This rate is based on a guaranteed consumption of not less than 120,000 kw-hours yearly, and is for lighting only. In consideration of this guarantee the rates charged are: For the first 15,000 kw-hours monthly consumption, 5 cents; from 15,000 to 25,000, 4½ cents; from 25,000 to 35,000, 4 cents; from 35,000 to 50,000, 3½ cents; all over 50,000, 3 cents. Should the bills at the rates specified exceed $17,500 in any year during the period of the contract, there shall be deducted from such bills an amount equal to the difference between the face thereof and the cost of the energy reckoned at the rate of 3½ cents per kw-hour, provided that the total amount of the bills for the year shall not be reduced to a sum less than $17,500. Should such bills, at the rate of 3½ cents per kw-hour exceed $20,000 in any year, there shall be deducted from such bills an amount equal to the difference between the face thereof and the cost of the energy reckoned at the rate of 3.2 cents per kw-hour, provided that the total amount of the bills for the year shall not be reduced to a sum less than $20,000. Should such bills at the rate of 3.2 cents per kw-hour exceed $25,000 in any year, the price of all the energy furnished during said year shall be reduced to 3 cents per kw-hour, provided that the total amount of the bills for the year shall not be less than $25,000.

Breakdown Service Rate.—This rate is based upon an annual guarantee of $30 for each kilowatt of maximum demand stated in the service contract. Within this guarantee energy may be consumed at the best rate of the class to the extent of the guarantee, without additional charge. Where the demand contracted for is less than 10 kw, the consumer pays the cost of installing the automatic switch, not exceeding $75.

High-Tension Service Rate.—This rate is based upon an agreement on the part of the consumer that the maximum demand contracted for shall not be less than 200 kw, costing $6,000 yearly. The rate is $30 annually for each kilowatt of maximum demand, a charge of 1½ cents per kw-hour being made for current consumed. This rate is for lighting only, and is applicable to large structures, important motor service, elevated, surface, subway and tunnel railroads and all other large installations permitting the use of 25-cycle alternating current of 6600 volts.

In addition, the New York Edison Company makes the following rates:

Automatic and Storage-Battery Rate.—This rate is based upon a monthly minimum guarantee of $50 and an agreement to use energy within certain hours. In consideration of these guarantees the rate is fixed at 6 cents per kw-hour, with discounts as follows: For monthly consumption of 3000 kw-hour, ½ cents per kw-hour; monthly consumption of 5000 kw-hours, 1 cent; monthly consumption of 8000 kw-hours, 1½ cents; monthly consumption of 10,000 kw-hours, 2 cents; monthly consumption of 25,000 kw-hours, 2½ cents; monthly consumption of 50,000 kw-hours, 3 cents.

Tunnel Construction Rate.—This rate is based upon an agreement on the part of the consumer to use the company's service exclusively and is for tunnel, surface and subsurface construction in connection with rapid transit or transportation lines on Manhattan Island or in the Bronx, or under the East, North or Harlem river. The rate is 4 cents per kw-hour, and is for lighting only.

Under the retail lighting agreement the New York Edison Company furnishes the first installation and the renewal of standard carbon lamps free of charge, except in the case of theaters, music halls, new buildings in the course of erection and "breakdown" service. Consumers are also entitled to free lamps under the Intermediate Wholesale agreement, and, where not supplied, a reduction is made in the case of the Intermediate Wholesale rate and for the exceptions noted under the Retail Lighting rate.

Under the Retail Lighting and Intermediate Wholesale agreements, the United Electric Light & Power Company furnishes the first installation and subsequent renewals of standard carbon or metalized filament lamps. The Special Wholesale rate does not include the supply of incandescent or arc lamps or their renewal or trimming.

BROOKLYN.

The Edison Electric Illuminating Company's schedule of rates is as follows:

Retail Lighting Service.—Twelve cents per kw-hour, with a guarantee of $2 per month, except in apartment houses and offices where more than one customer is supplied with energy, in which case the guarantee is $1 per month. Guarantee is waived during the months of June, July, August and September on residence equipment.

Intermediate Rate.—Ten cents per kw-hour, with a guarantee by consumer of 50 cents per month per 50-watt equivalent for eight months in the year, and 25 cents per month per 50-watt equivalent for four months in the year. Minimum guarantee $10 per month for eight months in the year and $5 per month for four months in the year.

Wholesale Rate.—For the first two hours' daily use of installation, 10 cents per kw-hour; for third and fourth hours' daily use, 7½ cents; all over four hours' daily use, 5 cents. Under this contract a guarantee of 750 kw-hours per month for eight months in the year, and that during such months the daily average use of the equipment shall not be less than one hour, is required. An allowance of 1 cent per kw-hour is made if consumer supplies and maintains his own equipment.

Special Wholesale Rate.—Six cents per kw-hour for the first 50,000 kw-hours annual consumption; 5 cents for the second 50,000 kw-hours annual consumption; all over 100,000 kw-hours annual consumption, 4 cents. The term of this contract is five years, and the guarantee is $3,000 per year.

Special Wholesale (Coney Island).—For 15,000 kw-hours and less than 20,000 kw-hours annual consumption, 10 cents; from 20,000 kw-hours to 30,000 kw-hours, 9 cents; all over 30,000 kw-hours, 8 cents. Term of contract, two years. Guarantee, $1,500 per year.

Advertising Lighting Rate.—$2.75 per 4-cp lamp per year; $4 per 8-cp lamp per year. Average use, five hours per night.

High-Tension Arc Lamp.—35 cents per night for service from one-half hour after sunset to 1 a. m.; 45 cents per night from one-half hour after sunset to one-half hour before sunrise.

Retail Industrial Rate.—10 cents per kw-hour, with discounts as follows: on monthly bills of over 200 kw-hours, 10 per cent; over 300 kw-hours, 20 per cent; over 500 kw-hours, 30 per cent; over 550 kw-hours, 35 per cent; over 750 kw-hours, 40 per cent; over 1750 kw-hours, 45 per cent; over 3750 kw-hours, 50 per cent. Guarantee, $2 per month.

Industrial Rate (Maximum Demand).—10 cents per kw-hour for first 25 hours or fraction thereof per month's use of maximum demand; 5 cents per kw-hour for the second 25 hours; 3 cents per kw-hour for all current furnished in excess of 50 hours per month's use of the maximum demand. Whenever the portion of the bill which is figured at 3 cents per kw-hour exceeds $25 the discount shall be 5 per cent; $50, 10 per cent; $150, 15 per cent; $200, 20 per cent; $300, 30 per cent; $400, 40 per cent; $500, 45 per cent; $1,000 and over 50 per cent. Guarantee, $50 per month.

High-Tension Service Rate.—Under this rate the consumer agrees that the maximum demand contracted for shall not be less than 200 kw, costing $6,000 yearly. The rate is $30 annually for each kilowatt of maximum demand and 1½ cents per kw-hour for energy used. This contract is applicable to important motor service permitting the use of 25-cycle alternating current at 6600 volts.

Under the Retail, Intermediate and Wholesale agreements (except where otherwise provided in the Wholesale agreements) the company furnishes the original installation and renewals of carbon incandescent lamps free of charge.

EXHAUST STEAM ICE MACHINES.

In an interesting paper read by Mr. Heywood Cochran, of Chicago, before the Nebraska Electrical Association, at its convention at Lincoln, May 3, the advantages of the use by central stations of exhaust steam for ice-making were brought out. Stations having steam-heating plants are becoming common, and where properly located prove profitable. If use can also be made of the exhaust steam during the summer months, he said, still greater profit can be obtained. Manufactured ice commands a decided preference in price, being made of distilled water, and ice plants are earning good dividends. If an ice plant operated independently is profitable it should be much more so if combined with an electric plant. The heavy load of the light plant occurs during the winter months, while that of the ice plant is during the summer. As an ice plant must be operated 24 hours a day, it becomes possible in smaller lighting plants to give 24-hour electric service profitably, and the ability to give this service will certainly increase the lighting and power loads. The only additional labor required is that for pulling and handling the ice, and this is a very small item.

One man on a 12-hour shift with an electric hoist can pull 25 tons, so that only two extra men would be required, one at day and one at night in plants up to 50 tons capacity. These men are usually paid about $2 per day, and as they do not come under the expert class, can be allowed to go at the end of the season. Usually in such combined plants the output is sold at a fixed price to local dealers, so that no extra office work is required. Where the plant is combined with a water works, the city water supply may be used for condensing purposes, as the quantity is usually so large that the temperature will not materially be increased, and it is not in any way deleteriously affected.

The two common systems used for ice-making are the ammonia compression and the ammonia absorption system. In both of these liquid anhydrous ammonia is compressed and then allowed to expand in coils in a brine tank, thereby giving rise to an extremely low temperature. In large compression plants with simple Corliss engines, the exhaust steam from the engine and pump, when condensed in steam condensers, will furnish at least 90 per cent of the distilled water required for making ice. In smaller plants frequently more distilled water can be obtained from these sources than can be frozen.

In the ammonia absorption system the heat of the steam is used for driving out the ammonia gas. Formerly live steam was used exclusively for this purpose, but within the last few years exhaust steam at low pressure has been used. As there is a trap on the outlet of these steam coils, all this exhaust steam is actually condensed and the distilled water is frozen into ice. The generator condensation only gives about 60 per cent of the distilled water required and the balance is usually condensed from additional engine exhaust.

When exhaust steam is available, as in an electric power plant, ice can be made as a by-product. The combined plant will use its exhaust steam largely in winter time for heating purposes and in summer time in an exhaust steam ice-making plant. Of course, where steam is not used for heating purposes, a large ice-storage house can be erected and the exhaust steam used for making ice the whole year, being stored during the winter months, as is done by the Holdredge (Neb.) Lighting Company. Mr. Cochran then referred to articles in three recent issues of the *Electrical World* on the subject of ice making, describing three different systems. In the April 1, 1910, issue the electric light and ice plant of the Lee Electric Company, at Clarinda, Ia., which has an ammonia compression machine, was described. In the March 3, 1910, issue appeared a description of the Hillsboro Electric Light & Power Company plant at Hillsboro, Ill., which is a live-steam absorption machine. In the April 7, 1910, issue was a description of the Holdredge Lighting Company's plant at Holdredge, Neb., which is an exhaust-steam absorption machine. The latter operates its exhaust at 3-lb. pressure. All of the auxiliary pumps are electrically driven. A similar plant is soon to be started at Grand Island.

A third of a ton of ice per day can be made per horse-power of engine. Usually the exhaust-steam supply in the electric power plant largely exceeds the amount of ice that can be disposed of. The amount of back pressure required is dependent upon the temperature of the condensing water available. With well water of 60 deg. or under, from 2 lb. to 3 lb. exhaust steam are sufficient; with ample cooling surfaces, 3-lb. pressure is sufficient where the condensing water is as high as 70 deg. Where the condensing water is taken from rivers or streams, or is used over and over again in the cooling tower at temperatures of from 80 deg. to 90 deg., it is necessary to use exhaust-steam pressures of 15 lb. to 25 lb. to condense the gas. In this case it would not be advisable to put such pressures on the engines, although back pressures of this order can be used on boiler-feed and other pumps.

In large plants having turbine or compound condensing engines, the steam should be taken from either the second stage of the turbine or from the receiver between the high-pressure and low-pressure cylinders of the compound engines. In these latter cases, of course, a certain amount of live steam would have to be charged up against the ice plant. However, the additional steam would hardly be more than one-fourth as much as is used in an independent ice plant.

With the exhaust from every three engine horse-power it is possible to make a ton of ice per day. With a 100-hp engine then it would be possible to make 30 tons of ice. At only $2 per ton, this would make a total of $60 per day. At Holdredge, Neb., ice is sold on the platform at $3.50 per ton. The whole question is how much ice can be sold, and what price can be obtained for it.

An ice plant costs roughly from $800 on the larger sizes to $1,200 on the smaller sizes per ton. To this must be added the cost of the water supply—that is, the well and pump. The investment, therefore, for an ice plant is very much less for a given amount of gross earnings than for the electric light part of the plant. This is shown clearly in the articles previously mentioned on the Hillsboro, Ill., and Clarinda, Ia., plants.

At Holdredge, in spite of the back pressure on the engines, the coal cost per kw-hour during 1909 with the ice plant was less than during 1908 without the ice plant. This was due to

the fact that besides the added load due to the ice plant, the commercial load was also greater and the engines ran more economically when more fully loaded. This greater economy more than offset the effect of the back pressure. At Holdredge the average amount of electricity used for all purposes about the ice plant was about 16 kw-hours per day per ton of ice made. Of this about three-quarters was for pumping water, which had to be lifted 165 ft. The ammonia pump and the agitating propeller in the icetank require very little power.

The Lima Ice & Storage Company, at Lima, Ohio, operates a 30-ton plant from the exhaust steam of a neighboring electric plant. The building, with storage-rooms, cost, with insulation, $4,800, or $1.20 per square foot of floor space.

Mr. Cochran said that at the Grand Island (Neb.) plant, part of the distilled water for ice-making is to be obtained from the surface condenser of the engine. The repairs on an ice plant will depend on the water which is used. The absorption machine has somewhat more pipe work than the compression machine.

DISCUSSION.

Mr. L. J. Schwingel, general manager of the Holdredge Lighting Company, said that his plant had been very successful. Some questions were asked as to the investment per ton of ice-making capacity. Mr. J. R. Cravath said that the true way to figure the capacity of any ice plant is on the basis of the number of tons of ice which can be sold per year. This amount will be dependent very much on the number of tons which can be delivered during the hottest weather. The demand for ice, like the demand for electric light, must be supplied at certain short stated intervals, when the public demands the service. He estimated the capacity of the Holdredge plant, which has a machine of 10 tons daily capacity, as being sufficient to deliver 28 to 30 tons per day for a summer season of 100 days. This is on account of the large storage capacity. Under the conditions prevailing in an independent ice plant, it would not pay to put in large storage and operate the plant the year around, as it would cost too much to refrigerate the storage to keep the ice. In the case of the Holdredge plant, however, the cost of keeping the storage-room refrigerated was almost nominal, as the electric plant was operating every day in the year, and had its exhaust steam as a by-product. This being the case a large storage capacity for ice was advisable. The real capacity of the Holdredge plant, however, should be considered as 28 or 30 tons instead of 10 tons per day.

Prof. C. R. Richards, of the University of Nebraska, said that he saw no better way of conserving energy than manufacturing ice in this way. Ice is now a necessity, and no longer a luxury. The cost of manufacture should not be over $2 per ton, and the sale should yield a percentage on the investment far above that for the electric light and power plant investment.

Mr. B. C. Adams, president, thought that central-station men should give very careful attention to this matter. Mr. L. J. Swingel, of Holdredge, advised the central-station men going into this business to keep out of the retail end of the business. His company sells to dealers at Holdredge, Minden and Bertrand. There are plenty of grief and many complaints connected with the retail ice delivery business.

Professor Richards thought that artificial ice could be made cheaper than natural ice could be harvested. Mr. Cochran said that this would depend upon the conditions. If the lake from which the ice is harvested is near towns, the cost of natural ice is very low. He cited the case of a brewery at La Crosse where the cost of cutting and hauling natural ice was 40 cents per ton. In addition to this four men were required to handle the ice in summer. However, under the particular conditions there, the artificial ice plant was able to beat this figure by using the same four men for operating the plant. It must be remembered, however, that artificial ice always commands a premium in price, because of its purity. In a certain Iowa city where the natural ice is taken from a river, the artificial ice commands a price $1 per ton higher.

Mr. W. J. Scoutt, of Kearney, said that there is a lake near his town at which a local concern harvests ice and fills ice houses at a cost of 20 cents per ton. The shrinkage of this ice in two summers was not enough to require the refilling of the ice houses. The cost of distribution is figured at about $2 per ton. There is also an artificial ice plant in Kearney. Natural ice delivered sells for $5 a ton, while artificial ice is $6. This is in spite of the fact that analysis shows but very little difference in the water from the two kinds of ice. Mr. H. A. Holdredge called attention to the large field for the small compression ice machine supplied with central-station electric power. His company in Omaha has a large number of such machines connected.

COMMON FIRE HAZARDS OF ELECTRIC LIGHT AND POWER PLANTS.

By W. J. Canada.

The study of power-station design by engineers has been directed toward permanence and assured continuity of service. Study and experience together have evolved a station which to-day eliminates wood structural members almost entirely. The greater permanence of conduit wiring has led to the general adoption of this form of construction where voltage is limited. Boiler-rooms in modern station design are more thoroughly cut off than formerly from engine-rooms, thus saving bearings and breakdowns due to dust accumulation. A brick wall is ordinarily used instead of frame partition, because roof spans to-day practically demand the former, and the life of the brick wall is better. Cement floors or tile floors have largely replaced the older and less permanent wood floor construction. Whether with intent or otherwise, these improvements have, with many others in switchboard design and the like, co-operated to make a modern station a much better fire risk than the older type. It seems possible that many of the improvements in fire hazard have been entirely incidental, but fire losses in these plants are decreasing and the result is a proper demand by plant owners for lowered insurance rates.

It is readily observed, however, that the advantages of the initially fire resistive construction of any building may be largely neutralized by what may be called "faults of management." These include prejudicial additions or changes in building construction, and equally prejudicial storage of combustibles and like errors, all of which tend to make the best station a poor fire risk. For some reason the modern electric light and power station seems to suffer more from such defective arrangements than most other modern plants, which apparently indicates either a careless or an indifferent spirit of the management. Too often it apparently is the latter reason and a station otherwise operated with a most careful eye to economics and continuity of service, has both these imperilled by a total disregard of conditions which by the law of probabilities must sooner or later cause the destruction of the plant by fire. This negligence is less observable in the larger plants, but to some extent it exists everywhere and is the final cause of our enormous fire waste in this country, where the individual has the unique liberty of destroying his own or neighbor's property by carelessness, which is made a criminal offence by European national laws. The average station management, in other words, is not accustomed to deduce its own fire hazard from the small number of power-station fires, and underestimates this hazard and its contributory causes.

The older stations and those of less fire resistive construction, of course, present the same problem, but more seriously, although it is not impossible to find plants in which the careful attention to details of fire prevention may fully offset grave faults in the character of the building construction and equipment.

The average station throughout the country is neither the ideal modern station in walls, roof, floor and equipment, nor is it the ideal in maintenance of conditions. This average station, to the thoughtful engineer, will present many features, where the reduction of fire hazard is practicable and expedient. Fre-

quently considerations of better service from such improved conditions will combine with evidently reduced fire hazard and correspondingly reduced insurance rates to urge upon the prudent manager the early institution of the improvement.

If the attention of station managements would be sufficiently directed to fire hazards within their control and to a large extent independent of original station design, an improvement is within their reach which will make for better service and better economy from every standpoint. Owing to the greater attention usually manifested toward details of plant operation by a new management, we will presume such a new management to be aroused to the point of a thorough investigation of all fire hazards of the station, with the intention of correcting the defective conditions and at the same time securing the advantage in lower insurance rates.

The prevention of fire is of far more importance than its extinction, and especially so in the manufacture of such a commodity as electric energy, which cannot be economically stored. Therefore, the inspection of such a plant by its management will take an order somewhat as follows:

The average station will be found to have an unnecessarily large storage of oil, treatment of waste, considerable oily waste scattered about on engine frames, tucked between generator field poles, and the like. Often these conditions will be found associated with wood floors, full of oil themselves and ready to assist rapid combustion. Oil should be limited in quantity, if kept in the station; it should be in an incombustible room of good construction, which is provided with self-closing waste cans at a fair height above wood floors. Steps should be taken to insure the use of the oil-room. The engine cylinder is still a more convenient place for the oiler, and this condition will be found in 90 per cent of all plants, and that it may cause and spread serious fires in the best of plants there is occasionally proof.

At the average switchboard will be found a few temporary wooden panels, carrying live buses, and the additional wiring is covered with highly inflammable insulation. Some of these "temporary" panels have probably been in place some years. Further, the floor about this switchboard will be wood, and coats will be found hung on the wall behind it. All the conditions are favorable for a fire, perhaps small, but which may put the switchboard, the whole plant in other words, out of commission. But the electrician has never known of such a fire and the management has relied on him. This hazard can readily be removed by installing permanent panels, replacing the inflammable insulation or covering it with flameproof hose, and installing concrete floor for a few feet about the board, with rubber walk strips. The coats will go into metal lockers on cement floor at some other point. Many cases will be found where lightning arrester protection is missing on feeders, or the arresters will be installed close to a combustible roof. A more common occurrence is the practice of tieing-in feeders from other stations or high-tension lines from generating stations entering without outside cutoff switches. In emergencies these conditions would prove very embarrassing, and possibly delay the extinguishing of fire, and so cause unnecessarily serious damage.

Another fruitful source of fire is a supply and repair room where considerable paint, oils, a few open cans of gasoline, a quantity of insulated wire and some line supplies may be found. Sometimes an arc-lamp repair and test-room is found; it usually has wooden frame partition, often wooden floor, not very infrequently some machine tools are used, and in fact most of the hazards of a small machine shop. Such an equipment the careful management should reduce to its lowest possible proportions, entirely remove paints and oils, place "no smoking" signs, use non-combustible shelving and partitions and concrete or iron floors. If possible to use another building for storage and repairs this should be done, but the common precautions taken in an ordinary repair shop should at least be taken here. Usually this feature of a power plant seems insignificant, as it is so entirely subordinated in the mind of the management to the energy production proper. But just these relatively small and usually neglected matters offer loopholes for fire hazard to creep in unobserved.

In the older stations more particularly, one finds wood-covered subways for cables from machines to switchboards. The cable insulation is highly inflammable, and the subway may easily act as a flue in creating a draft and rapidly spreading the fire.

Inspection will in many cases reveal that the transformers, while possibly in a separate room from the generators and switchboard, communicate with the main room through ordinary doors; or, the transformer room is undrained, and possibly upon a level with the generator room. In either event the large amount of highly combustible oil, with its possibilities in the way of oil vapor explosions, offers a considerable fire hazard. The central-station manager is in the habit of recognizing the large fire risk in oil-storage plants, and the knowledge of hazard in oil lamps and gasoline lighting is a part of his commercial training. But his own transformer plant, heated gently at all times and dependent upon submerged coils, quick blowing circuit-breakers and lack of oxygen to support combustion, for the suppression of combustion when two adjacent turns break down or a bushing arcs over—this transformer plant has bred contempt by familiarity, though the comparative frequency of line transformer burnouts should make the fire hazard familiar. A standard automatic sliding fire door on the side of the dividing wall against the transformer oil hazard and a tight-fitting safe door on the other are the first steps of precaution. Careful drainage to a good distance from the plant will secure additional safety and confine any loss in case of burning oil to the transformers themselves.

In the average station will be found an expensive 12-in. or 16-in. brick wall between boiler and engine-room, and this is easily seen to be of advantage to the extent that it makes salvage greater than a wood partition, in case of fire. As a protection to the engine-room, however, from fires originating in boiler-room from coal or otherwise, the efficacy of the brick wall is largely destroyed by several wooden-door communications, which not only offer no resistance to fire, but actually assist by the amount of combustible material they contain. The double automatic fire door will correct this negligence. When it is considered that at least 25 per cent of all fires are communicated through walls of one kind or another through lack of proper protection, the benefit to be derived by protecting door openings from boiler to engine-room will be appreciated.

In the boiler-room the breeching or more often the iron stacks are usually close to the wood sheathing of the roof, and sometimes not effectively ventilated at that. More than one fire has originated at this point, when a proper clearance and a good ventilating hood would have made the danger virtually disappear, and in addition would have given longer life to the sheathing.

The wood sheathing of roofs in both boiler and engine-room is far too common, in an otherwise well-constructed plant. Whether the determining cause be initial cost, or retention of heat or some other, the effect on the fire hazard is the same. A large amount of combustible material exists in a location where it is difficult to fight fire. This, however, is a fault in original design which cannot readily be corrected by the operating management. The proximity of iron stacks, wires, lightning arresters and service bushings is still within the control of the operator, and it must be remembered that there is frequent proof that such roofs burn, warp their steel truss supports, and fall upon the station equipment with unnecessarily large loss to the latter and unnecessarily long delays in reinstating service.

The last principal cause of fire hazard, which will be found remediable in the average station, is also quite usually a fault in design, and is the use of wooden floors. Wood is cheap, easily worked, and readily removed and replaced. The cost in 20 years or so of a wood floor will, however, fully equal that of an iron floor, and unless covering a mass of inflammable insulation, the latter can be depended upon to avoid any possibility of spreading fire along floors or contributing as a fuel to the severity of fire. Cleanliness, too, is almost impossible

with a wood floor, and in event of serious arcing in one machine on switchboard or on feeders, the wood floor may be relied on to communicate damage to some extent.

If within reach of city mains of adequate capacity, standpipes of liberal size, sufficient hose and connections give the best protection against spreading of fire. Negligence in drying such hose, its use for other purposes than protection, or its poor arrangement on racks, all operate in many stations, where the precaution of such protection was originally taken, to make the equipment useless in case of emergency.

For smaller fires chemical extinguishers and sand pails are quickly operated and effective. For small oil and insulation fires, dry sand is as effective as anything known. This sand should be in pails kept clean and in convenient vicinity of switchboard and machines. They are frequently found empty or missing from their proper places.

The advantage of proximity to a fire station, and the best of department equipment and personnel cannot be overestimated in case of serious fire, but the location of a power plant is necessarily determined by other factors. It is, therefore, the first aids, in the way of water, chemical and sand, inside protection in the use of which the station force should be instructed, which must be relied on to save those minutes at the incipiency of fire which usually determine the seriousness of the fire loss.

Managers will not fail to recognize the above as fire hazards, but their importance may most readily be determined by the co-operation between stations in listing each fire, however small, which it has suffered, even where no insurance loss was paid. Such a list, to the extent to which it is complete in territory and time, will also be advantageous in establishing a proper basis for insurance ratings. The greatest of all advantages to the central stations will be, however, in the better recognition of the relation of fire hazard to ultimate economy, and this recognition will be followed by an attention to fire prevention which will of itself reduce the hazard by half and the rate in proportion. All stations cannot be made over, nor can fires be abolished in them forever, but the reduction in insurance rate can in a majority of cases be shown to produce an interest on the improvement investment unequalled by the returns from operation. And there will be a certain gain in assurance of operating continuity.

Wiring and Illumination

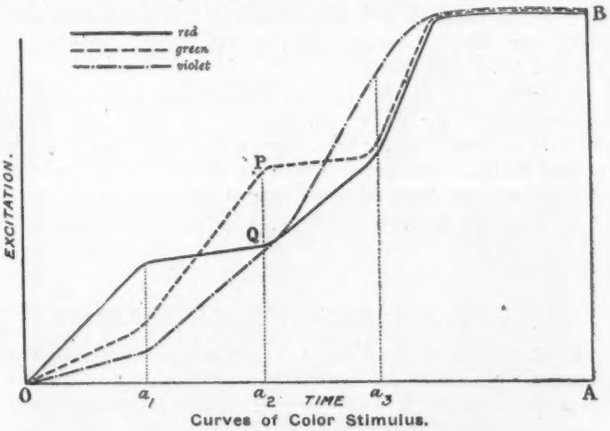
PHYSIOLOGICAL PHENOMENA IN FLICKER PHOTOMETRY.

In a paper read before the Newcastle Local Section of the British Institution of Electrical Engineers, Mr. H. Morris-Airey reported the results of observations made with the flicker photometer in comparing lights differing in color. The author stated, that from time to time, suspicions have been raised as to whether the principle on which the flicker photometers are based does not involve physiological phenomena, which disturb the conditions of illumination so that the numbers obtained are not a true representation of the illuminating powers of the sources to be compared. The exact role which the speed of rotation of the flicker head plays in the experiment is especially doubtful, while physiological evidence indicates that the effect is a very complicated one, and the simple theory of the flicker effect is not tenable.

The problem as to what actually happens in the retina when it is stimulated by steady or intermittent light is, of course, a physiological one, and in seeking for some generally accepted facts with regard to color vision, the most eminent physiologists are hopelessly at variance. The simplest physiological experiments seem to demand that the percipient structure of the retina involves two kinds of sensitive elements—the rods and cones. The rods are found in greatest numbers in the peripheral region together with a few cones, while in the small central region of clearest vision, the forea centralis, the cones alone are present, the intermediate zone containing rods and cones intermingled.

The function of the rods is to perceive light of intensity insufficient to stimulate the cones, but they appear to be of a primitive type of sense organ, being capable only of one kind of sensation whatever the color of the light falling on them. The cones, on the other hand, enable us to see in light which is bright enough to keep the rods in state of exhaustion. They have also the property of differentiating the various colors, the Young-Helmholtz theory assumes that they are of three kinds specially sensitive to red, green and violet respectively, any other color being capable of being represented as a combination of these in suitable proportions. These assumptions, said the author, enable one to explain many of the striking phenomena of color vision, such as the Purkinje effect, though recently doubts have been raised as to their validity, and it is certainly significant that many of these effects (including the Purkinje effect) have close analogies in the behavior of a photographic plate toward colored light. In this case a structure similar to that assumed for the retina seems excluded.

With every new theory of color vision the physicist would have to change his starting point in the explanation of phenomena like the flicker effect, and the author suggested that a more stable foundation for a physical theory is to be found in the experimental examination of the growth and decay of the retinal stimulus due to differently colored lights, without any attempt to connect the form of the curves obtained with physiological theories which are admitted of uncertain stability. The work of G. N. Stewart appears to afford the necessary data. In reference to Talbot's law of the fusion of intermittent light stimuli, Stewart found that on observing the flashes of light reflected from a rotating mirror placed in a darkened room, a series of color changes in the appearance of the image of the source took place as the speed of the mirror was altered. These changes take place at or under the speed necessary for the complete steady fusion of the flashes. The results are shown in the diagram.



Curves of Color Stimulus.

The three curves represent the growth of the stimulus for red, green and violet light. The time during which the light acts is measured horizontally, while the intensity of the excitation is given by the ordinates of the respective curves.

For a white light stimulus of long duration OA, the excitation of all three colors is equal, giving the sensation of white light. For stimuli of shorter duration, Oa_3, Oa_2, Oa_1, the violet, green and red excitations are predominant. The succession of colors in "after-images," as described by Helmholtz, Fechner and others, is consistent with the assumption that the decay of the excitation follows a similar set of curves.

Therefore, when the light stimulus consists of a series of short illuminations there may be different predominant tints, according to the length of the stimulus and its frequency.

As these colors are observed with intermittent light when the frequency is about or under that required for complete fusion

(i.e., disappearance of the flicker), the author said that it was difficult to avoid the conclusion that they will play an important part in the appearance of a flicker photometer head when used for comparing different colors. For instance, suppose the sources and speed of rotation to be adjusted so that the flicker has just disappeared and a balance is obtained. The flashes from either source considered independently evidently occur at a rate such that the excitation is not fully developed. If, for example, when comparing a red and a green source and the duration of each illumination corresponded to Oa_2, the effects actually being compared would be a red light of intensity $\frac{Qa_2}{AB}$ times the real intensity and a green light whose intensity had been reduced by the ratio $\frac{Pa_2}{AB}$, and though the appearance seen by the eye might be a steady illumination whose color was that produced by mixing red and green light together, this can hardly be interpreted to mean that the actual brightness of illumination at the flicker head has been adjusted to be the same. If the speed of the flicker head is altered, the position of the ordinate is shifted, and the positions of the sources must be readjusted to regain the balance. The same thing will apply when the sources are not pure red and pure green, but differently tinted lights, such as a carbon-filament and a metal-filament lamp, and this in practice leads to the results observed by Lauriol, Wild and others.

Whatever may be the ultimate physiological explanation of the working of the flicker, M. Morris-Airey thinks the above discussion shows that the conditions under which the retina is excited during a measurement with the flicker type of photometer are not the practical conditions of illumination to which it is our object to apply the data we obtain from the experiment.

INTERIOR AND EXTERIOR ILLUMINATION.

At the meeting of the New York Section of the Illuminating Engineering Society held on May 12 three papers were presented for discussion. Mr. C. O. Bond described certain flame standards of light, including the Carcel, the Elliott and the pentane, which were shown in condition for service.

ILLUMINATION TESTS.

A paper by Messrs. P. S. Millar and C. H. Sharp gave a detailed discussion of illumination measurements made to illustrate methods which may be employed in the study of the illumination of an interior and to show the degree of accuracy which it is practicable to attain in work carried out with ordinary field equipment.

The tests were conducted in a room 12 ft. 7 in. long, 12 ft. 2 in. wide and 9 ft. 10 in. high. The ceiling was covered with white cloth. The walls were grayish white and the windows were covered with manila paper. For the ceiling and walls there were provided black cloth coverings which reflected practically no light, and which could be removed readily. The light source consisted of a single 250-watt bowl frosted metallized filament lamp equipped with a satin-finish prismatic-bowl reflector. Studies were made of the illumination on a horizontal plane 36 in. above the floor, on the ceiling and on the walls.

Measurements showed that the lamp produced a total of 779 lumens; 183 reached the ceiling directly, 382 reached the walls directly and 191 reached the reference plane directly, the incident observed illumination totaling 756 lumens, or within 3 per cent of the value produced by the lamp. On account of reflection and counter reflection the total flux on the ceiling had a value of 280 lumens; that on the walls 672 lumens, and that on the test plane 376 lumens. Thus the total incident and direct flux reached a value of 1332 lumens, as compared with 779 lumens generated, the apparent average absorption being 58 per cent.

In discussing the paper on illumination tests, Mr. Little made an analysis of the data presented showing that calculations based upon the absorption-of-light method of determining illumination gave results within 5 per cent of the values actually observed.

Mr. Millar stated that the absorption-of-light method deserves to be used more frequently in practice on account of the ease with which it can be applied in certain problems.

STREET LAMP REFLECTOR.

Dr. C. H. Sharp presented a paper devoted to a highly-effective reflector for street lighting, which was demonstrated in three different forms. The reflector is one which does not obstruct the natural illumination of regions near the lamp and which by radiating light otherwise wasted builds up the illumination in the dark parts of the streets. Use is made of two parabolic reflectors cut through vertically in the focal plane, back to back, with their lower halves cut away. The semi-

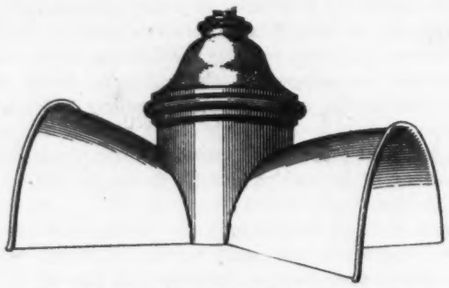


Fig. 1—Parabolic Street-Lamp Reflector.

paraboloids are inclined toward each other so that the two reflected beams will fall on the street surface at the required distance from the lamp.

An objection might be made to this arrangement on the grounds that a parabolic mirror throws a nearly parallel beam of light, and that the effect of the proposed arrangement would be to illuminate only a small area of the street by the rays coming from the mirror; that is, at a point midway between the lamps there would be a little bright patch which would amount to nothing as far as the general illumination goes, while the surrounding portions of the street would be left in darkness as before.

This objection would be a very valid one provided there were only a very small source of light in the focus of the mirror. Then the effect would be that of a search-lantern beam. In practice, however, the tungsten lamp affords quite an extended source, the result being that the beam of light is a divergent one and at a distance where it is effective it covers a considerable area. The angle of divergence of the beam is equal to the angle which is subtended at the mirror by the source of light; it is found in practice that this angle is sufficient to cause reflected rays to cover all the area of the street surface which is required.

An outline sketch of the parabolic street-lamp reflector is shown in Fig. 1, while a reflector as actually installed is illustrated in Fig. 2. In Fig. 3 are shown the results of observations of the illumination of a street by means of a 50-cp lamp without the reflector. The fixture was placed at a height of approximately 15 ft. above the street. The normal illumination produced at different distances by the lamp equipped with the parabolic reflector was then measured by a portable photometer and was compared to the illumination which would have been produced by the lamp alone. The latter was, however, excepting quite close to the lamp post, too small to be measured with any degree of accuracy. This test was conducted on a quiet residence street which was very badly illuminated by series incandescent lamps placed some 300 ft. apart. The illumination which these lamps produced was so small as to be negligible when taking the measurements. The illumination produced by the 50-cp lamp with reflector was striking in its effect on this street. One person meeting another approaching the lamp and at a distance of 500 ft. from the lamp could recognize the other's features. The normal illumination values obtained in this test are given in the curves of Fig. 3. Points

are put on the curves to show the standard values adopted for the magnetite arc lamp and for the 6.6-amp direct-current enclosed arc lamp as adopted by the National Electric Light Association. It will be seen that both of these values are considerably exceeded by the 50-cp incandescent lamp with reflector.

The author stated that with the parabolic street-lamp reflector of the enameled type a substantial gain of 100 per cent in the effective illumination can be obtained, while with the polished metal type the gain should be from 200 to 300 per cent. The latter type is of particular applicability to the illumination of country highways where for reasons of economy it is necessary that the lamps be placed at very considerable distances from each other. By the use of the polished metal reflector and such incandescent lamps as are ordinarily used for the purpose at the present time, a very acceptable highway illumination can be obtained with only ten lamps to the mile.

Pole Equipped with Parabolic Reflector.

An unexpected result was that the illumination directly below the lamps was somewhat higher than without the reflector, indicating a large amount of diffused reflection from the enameled surface.

The glare from the polished metal reflector is objectionable. However, this glare is not as great as is the glare from an arc lamp with clear globe, whereas the illumination produced by an 80-watt tungsten lamp with a polished metal reflector is at least comparable with that obtained with the ordinary type of arc lamp consuming four or five times as much power. Moreover, where shade trees do not interfere too greatly, tungsten lamps with polished semi-parabolic reflectors can be mounted at such an elevation above the road surface that the light does not fall too directly in the eyes of the travelers.

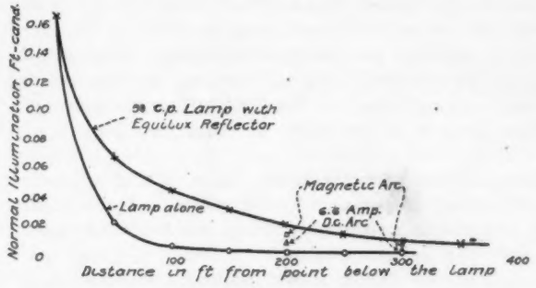


Fig. 3—Distribution Curves.

In discussing Dr. Sharp's paper, Mr. C. O. Bond expressed the opinion that certain advantages of reduction in glare and improvement in illumination efficiency could be obtained by making use of a lamp with the end of the bulb frosted to cover the filament from view and redirect some light to the reflector.

Mr. Bassett Jones, Jr., stated that the prime requisite in street lighting is to illuminate the street, and that light reaching the eye of the observer directly from the lamp is objectionable.

Mr. V. R. Lansingh called attention to tests recently conducted by Mr. A. J. Sweet tending to show that glare effect is a local retinal disturbance which, when sufficiently separated on the retina from the disturbance produced by the visualized object, does not extend to or affect the latter area of disturbance. Tests showed that when the lamp is placed so far above the eye that the light reaches it at an angle from the horizontal of not less than about 26 degrees the glare effect reaches zero.

Dr. John S. Shearer remarked that much data of great value to the illuminating engineer can be obtained by an investigation of the physiological aspects of directed and diffused lighting, concerning which accurate information is now quite limited.

ELECTRIC SIGNS IN MEMPHIS.

Three years ago Main Street, Memphis, Tenn., had five electric signs. At the present time the total number of electrical displays in the city has reached 300, representing with the special window lighting a connected load of 525 kw. This healthy growth in the electric sign business represents the careful work of the solicitors of the Merchants' Power Company, of Memphis, from one to three men having been employed on this work during the three years mentioned. The company sells the signs hung in place, assuring all the charges of erection and connection, in its contract of sale. The signs are supplied on a flat-rate contract basis, computed on $125 per kw-year, and are turned on at dusk by the company's employe and turned off at midnight. The supply of electric signs in Memphis has grown steadily and a number of pretentious displays have been erected.

View of Electric Signs on Main Street, Memphis.

THE LUMINOUS EFFICIENCY OF INCANDESCENT LAMPS.

The Emissivities of Filaments Considered from the Standpoint of Their Reflectivities.

By W. W. Coblentz.

Much has been written concerning selective emission as the cause of the high luminous efficiency of incandescent lamps, and no doubt a great deal more will yet be written before a complete solution of the problem is obtained. To say that "selective emission" produces the high luminous efficiency of modern illuminants may be quieting to the mind, but it will not assist in solving the question, nor will it assist in producing a more efficient illuminant. The question to be answered is the location and magnitude of the selective emission.

In previous communications the writer has called attention to the fact that all of the pure metals thus far examined, covering the whole range of the Mandelejeff series, have the common property of a low reflecting power in the ultra-violet rays and in the visible spectrum which rises abruptly to very high values beyond 2 μ in the infra-red rays, and that it is therefore not unreasonable to assume the unexamined metals, such as tungsten and osmium, to have this same property. In the regions of the visible spectrum where the reflectivity is low the emissivity must be high, and in the infra-red region the emissivity must be low because the reflectivity is high. Or, to express it more crudely, those frequencies which can enter the metal the most easily can get out of it just as easily, while the slow frequencies encounter opposition in their entrance and in their exit.

It is difficult to show experimentally this selective emission in other than colored metals (that is, gold and copper) by means of emission spectra. However, since the emissivity in the short wave-lengths appears to have only a small temperature coefficient, it is possible to gain some knowledge of the emissivity of the metal at high temperatures by determining its reflectivity at low temperatures. This method will give a positive qualitative proof of the much discussed and much overworked application of "selectivity" to explain the high luminous efficiency of metal-filament lamps.

While it is very quieting to the mind to assume that tungsten and other metal filaments must have optical properties similar to those of metals already investigated, it does not leave the

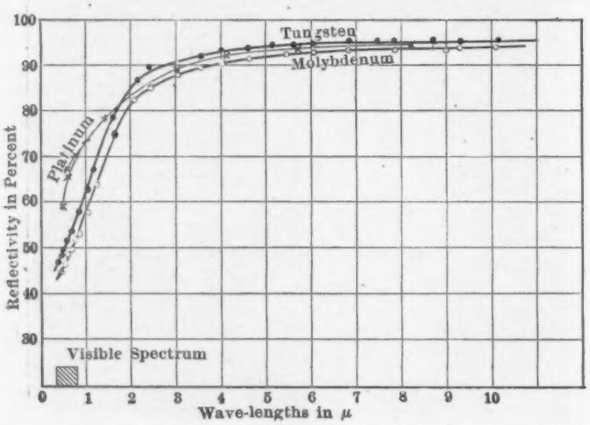


Fig. 1—Reflecting Power Tungsten, Molybdenum and Platinum.

assurance which comes from subjecting the question to experiment. Through the kind interest taken in preparing the material by the General Electric Company and by Siemens & Halske an opportunity was presented to examine large samples of pure metals. The reflecting surfaces were usually 5 mm x 17 mm. The unknown metal was compared spectrobolometrically with a plane silver mirror of known reflectivity, and from this the absolute reflectivity was ascertained.

As will be noticed in the appended illustrations, the previous assumptions of a low reflectivity (and hence high emissivity) in the visible spectrum has been verified to a degree far beyond expectation. For example, the emissivity of tungsten is almost 50 per cent, while in the infra-red region it is only from 5 to 10 per cent of that of an ideal radiator or "black body."

In Fig. 1 it will be noticed that the reflectivity of tungsten rises abruptly from a low value of 50 per cent in the yellow to 89 per cent at 2.5 μ, beyond which point it increases gradually to 96 per cent at 10 μ. This is a characteristic of pure metals.

Hagen and Rubens[1] have shown that for long waves (greater than 12 μ) the absorption (100 — Reflectivity) of a metal may

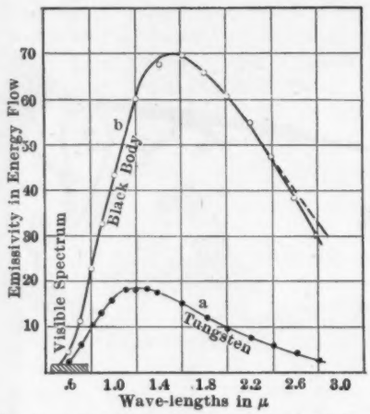


Fig. 2—Emissivity of Tungsten and a Black Body.

be computed from its electrical conductivity by means of the formula $100 - R = \frac{36.5}{\sqrt{C\lambda}}$ where R is the observed reflecting power, C is the reciprocal of the resistance in ohms of a conductor 1 m long and 1 sq. mm in cross-section, and λ = wave length in $\mu = 0.001$ mm. From the specific resistance (0.0000063 at 21.5 deg. C.) of this sample of tungsten the computed reflectivity at 12 μ is 97.3 per cent, while the value obtained by extrapolation is 96.3 per cent. This is in closer agreement than is to be expected from the difficulty in making observations in the extreme infra-red region and from the small size of the mirror.

The reflectivity is practically the same as platinum (except in the visible spectrum) from which it follows that in a previous investigation of the radiation constants of metals it was permissible to assume that the same emissivity law obtains in tungsten and platinum.

In Fig. 2, curve *a*, is given the spectral energy curve of a new 110-volt, 32-cp tungsten lamp when operating at a normal consumption of 55 watts. The maximum emission occurs at 1.225 μ. Using the formula $\lambda_{max} T = 2620$ of platinum and the value $\lambda_{max} = 1.225\ \mu$ of tungsten, the operating temperature is 1870 deg. C. From the observed radiation curve *a*, Fig. 2, one can obtain the equivalent black body curve *b*, at the same temperature by dividing the observed emissivities by the absorptivities (100 — reflectivity) of tungsten given in Fig. 1. The maximum emission lies at about $\lambda_m = 1.45\ \mu$, from which the computed temperature (using $\lambda_m T = 2940$) is about 1760 deg. C. It therefore appears that the "normal" temperature of the tungsten lamp is of the order of from 1800 deg. C. to 1850 deg. C.

The reflectivity of molybdenum, Fig. 1, is slightly lower than tungsten, being 46 per cent in the yellow and rising abruptly to 85 per cent at 2.5 μ, beyond which the reflectivity gradually increases to 95 per cent at 10 μ.

The reflectivity curves of molybdenum and tungsten are so nearly alike that from a consideration of their emissivities (100 — reflectivity) there seems to be no great choice in the use of these two metals in incandescent lamps. On the other hand, from a consideration of their physical properties the molybdenum filament would be preferable because of its toughness and its ductility in contrast with tungsten, which is very

[1] Hagen & Rubens. Ann. de Phys. Vol. IV, p. 873, 1903.

brittle. Both of their melting points are high, and with molybdenum it is principally a question of overcoming, if possible, certain physical weaknesses in the filament in order to make it practical for incandescent lamps.

The equality in the reflectivity curves shows that at the same temperatures their emissivities and hence their efficiencies must be practically the same. It therefore remains to be seen whether the molybdenum will admit of an operating temperature which obtains in the tungsten filament.

The reflectivity curve of a highly polished sample of Siberian graphite is shown in Fig. 3. The reflecting power rises gradually from 23 per cent in the visible spectrum to 60 per cent at 10 μ. From this low reflectivity at from 1 μ to 2 μ there results a high emissivity, hence the graphitized-carbon filament cannot have the same luminous efficiency as the tungsten lamp at the same temperature, although it has the higher emissivity in the visible spectrum.

The reflectivity curve, Fig. 3, of a sample of supposedly pure tantalum is lower even than graphite in the visible spectrum. There is no indication of an approach to a high and constant reflectivity in the infra-red region, such as obtains in pure metals. (See Fig. 1.) The reflective spectrum of tantalum (at least of this sample, which was supposed to be pure) has the characteristic of an impure metal or an alloy. Under the

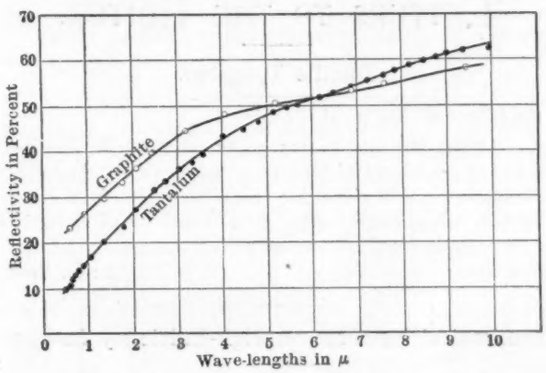


Fig. 3—Reflecting Power of Tantalum and Graphite.

microscope the sample appeared flawless, so that the low reflectivity cannot be explained on the hypothesis of roughness and scattering of the light. This low reflectivity in the visible spectrum produces a high emissivity, but contrary to the properties of pure metals, such as platinum and tungsten, the reflectivity continues low (emissivity high) in the infra-red region, which lowers the luminous efficiency. The normal temperature of a tantalum lamp is not much below that of tungsten, and hence, its low efficiency as compared with tungsten is to be sought for in its low reflectivity (high emissivity) in the infra-red region. On the efficiency basis tantalum must be classified with graphite (a non-metal) which is an anomalous classification. However, the reflectivity curves, and the previously observed radiation constants (total radiation; tantalum proportional to the 5.3 power and graphitized carbon proportional to the 5.1 power of the temperature), show that this classification is consistent.

The optical behavior of the sample of tantalum examined, and the close resemblance to the lamp filaments and to some thin strips of this metal which the writer has examined, make it of interest to learn whether the squirted material is a pure metal free from carbide. Tantalum filaments are very black and non-metallic as compared with tungsten and osmium. In fact, an ordinary tantalum filament appears darker than the mirror examined. If the pure metal has really such a low reflectivity throughout the spectrum, then there is ascertained the first real exception to a long list of more or less thoroughly examined metals numbering some 18 or 20 in all. If, on the other hand, as with the early products of supposedly pure boron, the metal is not pure, it may yet be possible to classify tantalum with tungsten (and molybdenum) as a high-efficiency illuminant.

These results on tantalum obtained by optical methods are not inconsistent with electrical tests. The resistance of an incandescent tungsten filament is from 8 to perhaps 10 times its cold resistance, showing a high coefficient as with pure metals. This relation seems not to be true of tantalum.

Efforts are being made to secure perfectly pure tantalum, which no doubt will have a higher reflecting power than here recorded.* (See Wartenberg, *Verh. Phys. Gesell.*, 11, 1910.) Nevertheless, the new results cannot materially alter the aforesaid conclusions, for the mirror already examined appeared just as bright as the filament of a new incandescent lamp while old filaments appeared much darker than the mirror.

In conclusion, it may be added that the ideal solid radiator giving a high luminous efficiency must fulfill the condition of a high operating temperature, a high reflectivity (hence, low emissivity) in the infra-red region, and a low reflectivity (high emissivity) in the visible spectrum. The pure metals, tungsten and molybdenum, fulfill these conditions more exactly than do any other known metals. This fact is illustrated in Fig. 1, in which is shown the reflectivity of platinum, which has heretofore been considered the most selective of metals in its emission in the visible spectrum.

COMMENTS ON RADIATION LAWS OF METALS.

In an article by the present writer, which appeared in the issue for Dec. 19, 1908, attention was called to the fact that, following the analogy with metals of known reflecting power, it is to be expected that tungsten, etc., will be found to have similar properties; namely, a low reflecting power in the visible spectrum and a high reflecting power in the infra-red, which is the true cause of selective emission and the high luminous efficiencies of metal-filament lamps. Now after almost two years of searching for suitable mirrors to test the reflectivities this has been verified beyond all expectation. Attention was then called to the fact that the unmodified Wien equation cannot apply to metal filaments, and the present data supports this conclusion.

The constant, a, in the Wien equation, and as used by the writer in the computations, relates to a specific spectral region; and irrespective of the author's published data, experiments by others show that the emissivity of metals at any wave-length in the infra-red spectrum is affected by the temperature; that is, it has a temperature coefficient. But this is not all. At low temperatures the maximum emission E_m falls in the region of from 3μ to 6μ, where the reflecting power at a given temperature is practically constant and one has to consider only the change in the radiation constant a due to the temperature coefficient of the reflectivity. At high temperatures the maximum emission occurs in the region of 1.5 μ (see Fig. 1), where at any given temperature the reflectivity changes rapidly with wave-length; and as it shifts toward the short wave-lengths the maximum emission must increase by a different law (from the Wien equation $E_m = BT^a$) from what it did when at from 3 μ to 6 μ. In the region of 1.5 μ the temperature coefficient is small, but the absorption (100 — reflectivity) varies rapidly with wave-length, while beyond 3 μ the conditions are exactly the reverse. In both cases the emissivity, E_m, increases in a different manner than postulated by the simple radiation laws. Now from the Wien equation $E = c_1\lambda^{-a}e^{-c_2/\lambda T}$ the radiation constant a is computed from the equation:

$$a = \frac{\log E - \log E_m}{\log e - \frac{\lambda_m}{\lambda}\log e + \log\frac{\lambda_m}{\lambda}}$$

where E and E_m are the emissivities at the wave-lengths λ and λ_m, respectively. It will be noticed that the question of the temperature of the filament does not enter this equation. From

*Some preliminary measurements on a regulus of pure tantalum, kindly sent to the author by Dr. Von Wartenberg, exhibited a reflecting power of 44 per cent in the yellow region (as was observed by Wartenberg), which rises abruptly to about 91 per cent at 2.5 μ and then increases gradually to 95 per cent beyond 8 μ. The theoretical reflectivity computed from the electrical conductivity is at least 96 per cent. These results show that the sample previously examined was far from being pure. This means that a filament of pure tantalum should be as bright as that of tungsten, which is by no means true of the present filaments.

the most recent work of Hagen and Rubens it appears that from the visible to 3 μ the temperature coefficient of emissivity is extremely small and the observed variations in a with temperature, as computed from the above equation, must be due to some other cause than a true temperature coefficient of emissivity. This cause is not difficult to find if one turns to the reflecting curves of Fig. 1. At low temperatures, when the maximum wave-length, λ_m falls in the region of 2 μ, the E_m is only slightly affected by the temperature coefficient of emissivity, and since the reflecting power varies quite slowly with the wave-length, the value of E_m will probably be closely that indicated by the Wien equation. At high temperatures, when the maximum wave-length falls in the region of 1.2 μ, the maximum emission falls in the region where the reflectivity changes rapidly with wave-length, and consequently its value must increase at a more rapid rate than required by the equation $E_m = BT^a$. The difference between log E and log E_m must, therefore, be less than would otherwise be the case, due to this fact, and the decrease in a with the temperature, when computed from the above equation must necessarily follow, as observed. Whether this is the true cause requires further proof, but it is evident from the reflection curves that this is a plausible explanation and that an accurate value of a cannot be computed from the Wien equation as expressed above. However, from the close agreement between the values of platinum by this and by more direct methods it is evident that the errors resulting from the use of the above equation are not serious.

The aforesaid work has shown in a fairly qantitative way that the radiation constant a of tungsten is much higher than that of platinum and of carbon. The great suppression of the radiation of tungsten as compared with carbon in the infra-red is another proof of this. The Wien spectral energy curves, using different values of a, illustrate this same behavior.

It seems evident that any accurate radiation formula that can be set up must contain factors which will take into consideration the variables just mentioned. It will be an interesting experiment to determine whether the same variable factor will satisfy the phenomena affecting E_m at low and at high temperatures.

Whether the "constant" a really varies as stated in the previous article, where the Wien equation was tentatively assumed, or whether the constant σ, which enters with a, in the Stefan-Boltzmann law, $S = \sigma T^{a-1}$, of total radiation varies, is not the all-important question at this stage of our knowledge. The most important thing is to get further data, using thin, wide strips of these metals with a thermocouple between them to measure the temperatures. Experimenters should produce new and diversified data instead of spending time in trying to find flaws with the old;; wide strips of pure material, which previously could not be had, are now obtainable. It is to be hoped that our large lamp factories with their facilities for preparing pure material will continue their interest in such investigations, for it is only through such co-operation that experimental work can progress, as witness the present data on mirrors made of the metals just described.

NEW TELEPHONE PATENTS.

MESSAGE RECORDING SYSTEMS.

Most mechanical recording of telephone connections or messages has been done by means of counters. These counters are operated either automatically with the completion of the proper series of steps incident to the completion of a successful call, or are operated as the result of some special action on the part of the operator, such as the depression of a key. In neither case is there left any permanent record of the individual call; the counting train merely indicates the total up to the time of reading. In distinction to this method a system of true recording was recently patented by Mr. E. E. Clement, of Washington, D. C. With this system there can be recorded all necessary data concerning a call to identify it, thus: operator's number, date, time, etc. Record is made from a printing machine, one of which is associated with each cord pair. By the association of an automatic selector apparatus with the jacks circuits of all lines to be answered with any one cord, the selector may be made to advance automatically until it picks up that particular line. The extent of travel of the selector shaft is, of course, a constant for each particular line and this movement may thus be connected to drive the type wheel, which in this case will carry telephone numbers in proper sequence. The printed record of all the desired data is made upon a tape, the impression being made incidental to the operation of the supervising relay of the cord circuit in use.

AUTOMATIC TELEPHONE.

An improved dial for automatic telephones forms the subject of a patent granted to Mr. D. W. Kneisly, of Dayton, Ohio. He uses the finger-hole dial-plate as a basis, and the improvement lies in providing a positive stop. As generally constructed, the user's finger is the stop gage, and if the sizes of the fingers of different users vary sufficiently, false connections may result. Mr. Kneisly utilizes a strip of spring material at the bottom of each finger hole. The user unconsciously depresses this spring so that its edge will strike the stop plug. Thus, the stop position becomes fixed.

LETTERS TO THE EDITOR.

Ductile Tungsten.

To the Editor of Electrical World:

Sir:—In the abstract of my paper on "Ductile Tungsten," published in your issue of May 12, 1910, page 1185, the temperature coefficient value given for tungsten, 0.0091, is a misprint, the correct value being 0.0051. The resistivity of hard-drawn tungsten wire is 6.2.

Schenectady, N. Y. Colin G. Fink.

Economical Features of High-Efficiency Lamps.

To the Editor of Electrical World:

Sir:—Many of the arguments advanced concerning the advantages and disadvantages of high-efficiency lamps to the central-station industry, it seems to the writer, fail to bring forward the very features which are of predominating importance. That high-efficiency lamps are better for the central station than are low-efficiency units will be appreciated at once if one considers the disastrous effect that would be produced upon the industry by substituting lamps consuming, say, 9 watts per candle for those now using 3 watts; surely the reverse effect should be expected from a change in the other direction to lamps of, say, 1 watt per candle.

It is sometimes stated that the central-station industry would suffer if high-efficiency lamps were placed upon the market at a very low price, and that, therefore, the manufacturers should not offer these lamps for sale at too low a figure. It is difficult to understand the basis for such a statement, for it can be shown that the best interest of the central station dictates the sale of the high-efficiency lamps at the lowest possible price. Assume for example a certain 25-cp lamp consuming 3 watts per candle and another lamp giving the same amount of light and consuming only 1 watt per candle. Assume further that each lamp has a definite life of 800 hours. The 3-watt lamp will consume a total of 60,000 watt-hours and the other lamp 20,000 watt-hours during life, At 10 cents per kw-hour, the cost of energy for the former lamp will be $6 and that for the latter $2. It is evident, therefore, that to the customer the latter lamp is worth $4 more than the former. That is to say, the customer could afford to pay $4 more for the high-efficiency lamp than for the low-efficiency lamp, because he would save just this amount on his bill for energy. If the manufacturer were to demand a price of $4 per lamp more for the 1-watt than for the 3-watt unit, then the result would be that the

central station would lose $4 for each high-efficiency lamp used by its customers, as there would be no incentive whatsoever for the customer to increase the number of his lighting units and no tendency for the number of customers to increase by reason of the introduction of the high-efficiency lamps.

Consider now the effect upon the central-station industry of placing upon the market 1-watt lamps at prices identical with those now demanded for 3-watt lamps. So far as concerns the lighting customer, the result would be absolutely the same as reducing the rate for electrical energy to exactly one-third of its present price. Surely no one can doubt the effect upon all present lighting customers and prospective customers that would be produced by such a reduction in rates or the equivalent thereof. Each present consumer would be more liberal in the use of light, while practically everyone now using some other illuminant would turn to electricity. That the final lighting load would extend over a greater number of hours than the present, with its narrow pronounced peaks, admits of no doubt.

So far as concerns the lighting load on the central station, the change from 3-watt to 1-watt lamps would be the exact equivalent of a simultaneous two-thirds reduction in the price for energy and an exactly equal decrease in all costs connected with the generation of the energy. It should be evident at once that the enormous increase in the lighting business that would accompany a reduction in lighting rates to one-third of the present value would more than justify the reduction in case a discovery were made of some method by which all apparatus, wages and fuel could be obtained at one-third of their present cost.

It would seem from the foregoing that the central station should welcome any reduction that the manufacturers are able to make in the prices quoted for the high-efficiency lamps. To the extent that the price remains too high both the lighting customer and the central stations are losers, while the lamp manufacturer loses indirectly by the decrease in the possible sale of lamps. To a very large extent, the excess in price of the lamp represents money paid by the central station through the lighting customer into the treasury of the lamp manufacturer.

New York. A. M. STRATTON.

Digest of Current Electrical Literature

ABSTRACTS OF THE IMPORTANT ARTICLES APPEARING IN THE ELECTRICAL PERIODICAL PRESS OF THE WORLD

Generators, Motors and Transformers.

Transformer Cooling.—In an article by Mr. A. V. Clayton on water-power installations in Sweden the transformer construction employed at the Graninge plant is described with special reference to the arrangement of the cooling coils. Instead of having one or a few circulating pipes of large diameter, or a water jacket, the pipes consist of a number of copper tubes of small diameter placed in parallel, like a water-tube boiler.

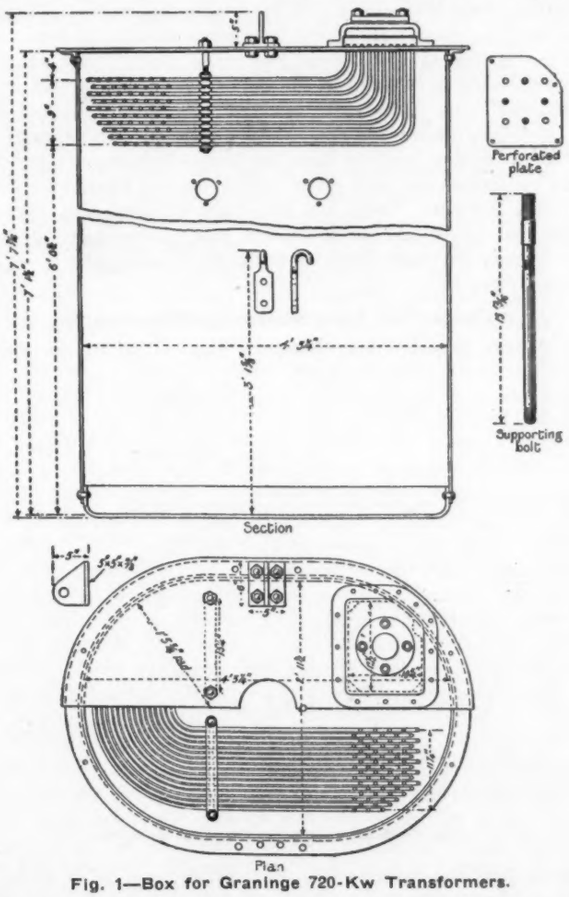


Fig. 1—Box for Graninge 720-Kw Transformers.

Fig. 1 shows the box and cooling coils. In this construction the tubes are expanded or sweated into headers which form one side of distribution boxes for the inlet and discharge of the circulating water. The entire system of cooling tubes is placed at the top of the transformer box over the transformer itself, and is attached to the transformer box lid, so that when the lid is removed the coils are removed with it. By employing this construction an enormous cooling area can be got into a very small space, practically the only limit to the room required for the cooling coils being the amount of space which must of necessity be left between the tubes in order to obtain good circulation of the oil. Moreover, the cooling coils are at the top of the box, where the oil is hottest, and hence in the most effective and best position. A very complete arrangement is provided for tapping out the oil, boiling and refilling. It consists of a system of pipes to and from the transformers connected with oil-boiling tanks. The use of oil-cooled transformers has of recent years become general in Sweden, on account of the larger units now employed and the high voltages used in the transmission of energy.—Lond. *Electrician,* April 29.

Commutator Construction.—A note on a recent British patent (1292, 1910; April 21, 1910) of the Siemens-Schuckert Company. Since there is a tendency for the hard mica now used to project above the surface of the commutator and cause sparking, the mica has been placed between the segments below the radial wearing depth only, the remaining portion being fitted with a soft insulating material which wears away easily. In high-speed machines, however, this soft material is thrown out by centrifugal force and accumulated carbon dust then causes a short-circuit between adjacent segments. According to the present invention the hard insulating substance extends only over the inner part, and a gap is left between the adjacent segments; but to prevent short-circuiting by carbon dust the sides of the segments are insulated with varnish or enamel, or a thin sheet of paper of mica glued to the segments.—Lond. *Elec. Eng'ing,* April 28.

Magnetic Leakage in Transformers.—E. G. REED.—An article profusely illustrated by diagrams discussing the magnetic leakage in transformers and its effect on their regulation under normal and special conditions.—*Elec. Jour.,* May.

Lamps and Lighting.

Tests of Incandescent Lamps; Assorting Lamps.—K. KEIL.—An account of tests in which the mean horizontal candle-power, the absolute power consumption in watts and the specific con-

sumption in watts per candle-power were determined as functions of the voltage. The candle-power of the osram lamp is proportional to the 3.85 power of the voltage, the consumption in watts is proportional to the 1.59 power of the voltage and the specific consumption is inversely proportional to the 2.26 power of the voltage. The curves for the osram lamp are given

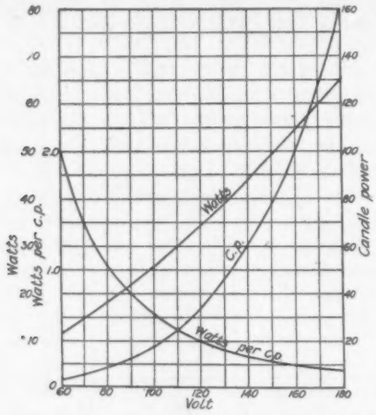


Fig. 2—Curves of 25 Hefner CP, Osram Lamp.

in Fig. 2. Similar relations exist for the Bergmann metallic-filament lamp, while for the carbon-filament lamp the numerical figure of the power in the candle-power equation changes. The figures of these coefficients are summed up in the following table:

Hefner cp.	Osram Lamp			Bergmann Lamp		
	b_L	b_A	b_S	b_L	b_A	b_S
25	3.88	1.58	−2.30	3.93	1.68	−2.25
32	3.81	1.59	−2.22	3.92	1.69	−2.23
50	3.85	1.59	−2.26	4.09	1.67	−2.42
Mean	3.85	1.59	−2.26	3.98	1.68	−2.30

Hefner cp.	Carbon Lamp		b_S
	b_L	b_A	
16	7.13 to 5.56	2.16	(−4.89) to (−3.52)
25	8.45 to 3.20	2.21	(−6.35) to (−0.78)
32	8.03 to 3.92	2.18	(−5.91) to (−1.84)
Mean	7.87 to 4.23	2.18	(−5.72) to (−2.05)

The meaning of b_L, b_A, and b_S is that the candle-power is proportional to the b_A th power of the voltage, that the watts are proportional to the b_A th power of the voltage, and that the watts per candle-power are proportional to the b_S th power of the voltage. The minus sign indicates that the watts per candle-power are inversely proportional to the stated power of the voltage. The resistance of the osram lamp is proportional to the 0.41 power of the voltage, that of the Gergmann lamp to the 0.32 power of the voltage and that of the carbon lamp is inversely proportional to the 0.1 power of the voltage. These results can be used in practice for sorting lamps. For instance, assume that all the lamps which are to be assorted are for voltages between 100 and 130; the tests may then be made at one and the same e.m.f., say, 115 volts. If the standard lamp is also calibrated for this e.m.f. (115 volts), the further advantage is obtained that the voltage regulation of both lamps may be made simultaneously, so that the variations of voltage are uniform for both. If osram lamps between 100 volts and 130 volts are to be sorted, the characteristic curves within this range of voltage are plotted on an arbitrary scale, as shown in Fig. 3. Assume that the candle-power of a certain lamp at 115 volts had been found to be 28.3 hefners and the power consumption 31.1 watts, so that the specific consumption is 1.10 watts per candle-power. In the diagram the ordinate at 115 volts represents, therefore, 1.10 watts per candle-power and 28.3 cp. The length of this ordinate may be chosen as 100 mm. But since a lamp of 1.0 (not 1.1) watt per hefner candle-power is

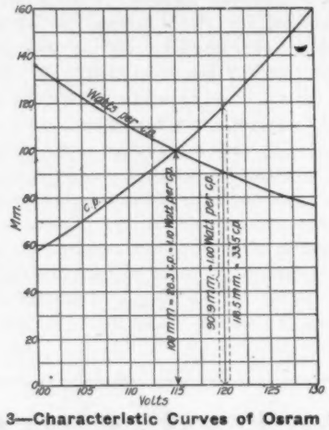


Fig. 3—Characteristic Curves of Osram Lamp.

wanted, coresponding to an ordinate $100 \times 1.0 \div 1.1 = 90.9$ mm, it is necessary to look up that ordinate of the specific consumption curve which has this length. The corresponding abscissa then gives the voltage at which the lamp is to be operated. In this example it is 120.2 volts. The ordinate of the candle-power curve at this voltage measures 118.5 mm, so that the candle-power is found to equal $118.5 \times 28.3 \div 100 = 33.5$ hefners. The lamp is, therefore, a 32-cp, 120-volt lamp. The author states that with a little experience this method of sorting is very accurate. He found in practice that lamps which had been marked as 25-cp lamps had really candle-power of 30 or more, while in other cases the candle-power was far below the marked value.—*Elek. Zeit.*, April 28.

Intensive Flame-Arc Lamp.—An illustrated description of the "Main" double intensive flame-arc lamp which permits 38 hours of continuous use with direct current and 35 hours with alternating current. There are two pairs of electrodes, each of 600 mm length, and when the first pair of electrodes has been consumed the second pair is switched in automatically.—*Elek. Anz.*, April 24.

Generation, Transmission and Distribution.

Driving Ring-Spinning Frames.—The tension of the thread

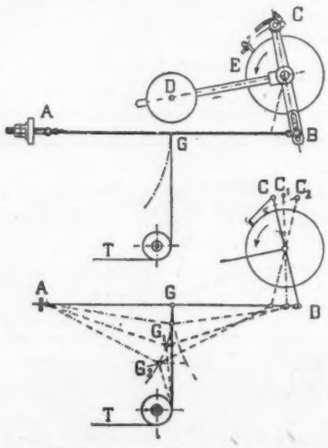


Fig. 4—Mechanism for Moving Brushes.

varies with the different diameters of the cop, being greatest where the smallest portion of the cop is being formed and least at the largest diameter; the variation, occurring with each lift of the ring rail, takes place between the traveler and cop. This variation has been a prolific cause of many broken ends and uneven windings, and it has led to many proposals for over-

coming these defects. The traveler performs the double function of twisting and winding the thread in a continuous process; it exerts a constant drag on the thread with constant spindle speed, instead of varying it according to the diameter of the cop. This difficulty can only be overcome by varying the frictional resistance to the traveler—that is, by varying both its speed and the spindle speed with each upward and downward movement of the ring rail. In a system of the Oerlikon Company use is made of a special three-phase motor with speed regulation characteristics similar to the direct-current type. The speed can be varied from 600 r.p.m. to 1430 r.p.m. when

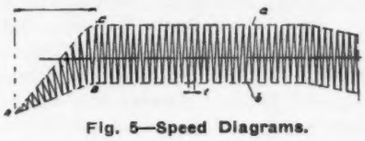


Fig. 5—Speed Diagrams.

running, by moving the brushes. One set of brushes is provided per pair of poles. The automatic apparatus for varying the speed is shown diagrammatically in Fig. 4, in which the movement of a rope *T*, attached at *G* to another rope *AB* causes a movement of the lever *BC*, resulting in moving the brushes *E* over the commutator, and thus varying the motor speed. The brushes undergo a slowly advancing and continuously oscillating movement during the formation of the cop, under the general control of the rope *T*, and this action results in a speed diagram such as shown in Fig. 5, which represents the fundamental basis of the Oerlikon drive. In this diagram line *a* represents the maximum spindle speed, line *b* the minimum spindle speed (when spinning the smallest diameter of the bobbin); the distance *t* shows the time for one up-and-down movement of the ring-rail, the zigzag representing the variations in spindle speed; the total length indicates the time taken for the whole operation of forming the cop; the falling line *AB* represents the gradually decreasing speed required for successfully forming the conical end or nose of the cop. In order to overcome the inertia of the spindle and insure that the apparatus governing the regulation of motor speed shall be in advance of the movement of the ring-rail by an amount exactly equal to the tendency to lag when changing speed, the Oerlikon Company has patented an automatic mechanism which operates the rope *T* of Fig. 4. This device is a purely mechanical arrangement for imparting the oscillating and gradual continuous movement to the brushes of the motor until the completion of the bobbin, when, under the influence of the balance weight, the brushes are returned to their original position. In practice it has been found that the method results in an increase in production and that a lighter traveler can be used on coarse and medium counts with the variable-speed drive.—Lond. *Elec. Rev.*, April 29.

Belgian Quarry Electrification.—Some statistical figures regarding the use of electricity in Belgian quarries. Some 7500 kw of electrical power is in use for quarrying and dressing stone in Belgium. For the former purpose winches take 2200 hp and traveling cranes 1500 hp; for the latter purpose cranes and transporters absorb 1400 hp; reciprocating pumps, 300 hp; centrifugal pumps, 900 hp, and the balance is utilized for motor-driven machinery, lighting, etc. This development concerns some 50 quarry companies, which in some cases supply energy to other industrial concerns in addition to their own plant.—Lond. *Elec. Rev.*, April 22.

Electric Motors in Textile Mills.—The issue contains quite a number of articles on this subject. Mr. W. B. Woodhouse discusses the electric drive of textile mills. Mr. W. H. Booth deals with ventilation and humidifying in cotton mills. The paper by Mr. A. Milmow on the electric drive in textile mills is concluded. An illustrated description of the electric group drive at the Mersey mills in Hollingworth is given, while an illustrated article by Mr. W. R. Rothenberg describes the electric individual drive in continental textile mills with special reference to the equipment of all machines on the single-drive system at Buchaly & Herbertz's new mill in M.-Gladbach.—Lond. *Elec. Rev.*, April 29.

Gas Engines.—Detailed drawings of three double-acting gas engines using blast-furnace gas at the Barrow steel works in England. Two have a rating of 750 hp and the third 1250 hp when running at 100 r.p.m.—Lond. *Engineering*, April 29.

French Water-Power Stations.—POSTEL AND VINAY.—A review of the water-power stations in the southwest of France. A description of the Tuiliere 24,000-kw plant which is partly operated by water-power and partly by steam turbines is given.—*La Lumière Elec.*, April 16.

Turbine Station.—A profusely illustrated description of the new turbine station of the Cincinnati Traction Company which has a rating of 18,000 kw. It is planned to double the equipment later on by adding a duplicate section with three 6000-kw turbo-generator units.—*Elec. Rail. Jour.*, April 30.

Traction.

Canal Haulage.—A. PALLIERE.—An illustrated article on electric haulage on the canals du Nord in France. Formerly tricycles running without rails along the canal and supplied with electrical energy from a trolley wire were used exclusively. While they are still being used, electric haulage by locomotives running on rails and receiving energy from a trolley wire are now being employed on a longer section and have been found less expensive. Tables giving the results of the tests and drawings of the locomotives are added.—*La Houille Blanche*, April.

Bavaria.—A continuation of the review of the project of introducing electric traction on the Bavarian State railways. In the present installment the direct-current, three-phase and single-phase systems are briefly compared and the economy of electric traction is discussed. The article is to be concluded.—*Elek. Zeit.*, April 28.

Installations, Systems and Appliances.

Parallelling Large Alternating-Current Systems.—P. M. LINCOLN.—A discussion of the problem of transmitting energy from one alternating-current system to another. The chief results of the discussion are as follows: Two alternating-current systems should not be connected together by a transformer or synchronous-motor-generator set having a rating smaller than 50 per cent of the smaller system. If a transformer or synchronous-motor-generator set be used between two alternating-current systems, the only method of regulating the amount of power taken through such a connecting link is to control the power output of the prime movers of one or both systems. With sudden fluctuations in load, accurate or rapid control of the energy interchanged when using such a connecting link is practically impossible. The proper method of exchanging energy between two alternating-current systems is by the use of motor-generator sets, at least one of whose elements is an induction machine. When using an induction motor as one of the links, the alternating-current system that receives power must operate normally at a frequency somewhat lower than the generator end of the connecting link would generate were the set synchronous on both ends. The number of possible pole combinations that may be used in connecting a 60-cycle and 25-cycle system is limited and the choice of combination should depend on the direction in which energy is to be transferred.—*Elec. Jour.*, May.

Earth Versus Insulated Neutrals in Colliery Installations.—W. WELLESLEY WOOD.—A paper read before the (Brit.) Inst. Elec. Eng. The author discusses in detail the advantages and disadvantages of working in a three-phase colliery installation with an earthed as against an unearthed neutral. Although a hard and fast rule cannot be laid down, he concludes that generally an insulated neutral is better where permanent plant is at work and the cables are not liable to injury. Where portable machines are used or cables are liable to damage, automatic devices may be installed. A separate transformer with earthed neutral might be used to supply energy to this plant.—Lond. *Electrician*, April 29.

Systems of Charging for Electric Lighting.—A note on a recent pamphlet of the municipal St. Marylebone central station in London for the benefit of their consumers and proposed consumers. The pamphlet contains a brief explanation, in as non-

technical language as possible, of the "maximum demand" and "telephone" systems of charging. After describing the principle of the maximum-demand indicator and the basis on which the consumer's bill is made out on this system, it is shown how much simpler is the "telephone" system of charging, all that is necessary being that the consumer must fill out a form (or let the electricity department's representative do this) stating the particulars of the lamps installed. From the number and candle-power of these lamps the annual fixed charge is determined, and for all energy consumed a further charge of 2 cents per kw-hour is made. In addition to simplicity, other advantages of this system are: (1) The consumer knows within about 10 per cent what his annual bill will be; (2) no special wiring or meter is necessary if electrical apparatus such as irons, kettles, stoves, fans, etc., are installed. A small annual charge is made for each piece of apparatus installed; thus, for an electric iron the annual charge (payable in advance) is $1.25, while for a four-lamp radiator the consumer would be required to pay $5, the energy consumed, of course, passing through the lighting meter, and being paid for at 2 cents per kw-hour. An annual sum of $10.50, however, allows a consumer to install as much heating and other electrical apparatus (apart, of course, from lighting) as he wishes. The "telephone" system can only be applied to premises where electricity is used throughout for lighting purposes. It is, however, a distinct advance in methods of charging, and should do much to popularize still further the use of electric lighting and all forms of electrical apparatus. The fact that $35,000 has been received in St. Marylebone in annual charges payable in advance since this system came into use is an excellent testimonial to its value.—Lond. *Electrician,* April 29.

Charging for Electrical Energy.—E. Melchert.—An illustrated description of a device by means of which it is possible to separate the hours of peak load from the hours of low load and to read them from a meter. The author proposes a new method of charging based on this separation and simultaneous measurement of the energy consumed during the two different kinds of hours and compares his method with the usual double-charge method.—*Elek. Anz.,* April 24.

Storage Batteries on Alternating-Current Systems.—A note on a recent British patent of A. M. Taylor (2147, 1909; April 21, 1910). Low-voltage storage-battery units, each of a few cells, of large rating, are installed in a substation on a high-tension, alternating-current distribution system for the purpose of relieving the generating station of the peak loads, and for improving the power-factor of the system. Each set, comprising a battery, a synchronous motor-generator, and a transformer, is connected to the low-tension side of the main transformers. The excitation of one motor-generator is controlled automatically from series and shunt instrument transformers on the outgoing feeders, so that it is overexcited and (running as a motor) takes enough leading current to compensate for the lagging current of the load. Another motor-generator is automatically controlled so as to compensate for the lagging currents on the high-tension side. All the motor generators are driven from the batteries to supply alternating-current energy for the peak loads. A method of inserting a transformer (fed from a battery unit) into the high-tension feeders to compensate automatically for the reaction or capacity of the transmission line is also described.—Lond. *Elec. Eng'ing,* April 28.

Storage Batteries in Central Stations.—R. Werkner.—A translation into French of his recent German paper on the use of storage batteries in direct-current and alternating-current central stations.—*La Lumière Elec.,* April 23.

India.—Beresford-Lovett.—The first part of an illustrated article on the development of electrical industries in India, giving statistical figures and general notes on electric traction, lighting and water-power stations in India. The electrical industry in India is still in its infancy, the total equipment being rated at not more than 36,650 kw. A map showing the different electrical installations is added.—*La Houille Blanche,* April.

Wires, Wiring and Conduits.

Potential Against Earth.—G. Vallauri.—A paper read before the Italian Electrical Society. In an electric transmission and distribution system of which no part is directly connected to earth, there is equilibrium of potential with respect to earth under normal conditions. But if the insulation resistance of one of the systems of conductors is lowered this equilibrium of potential is disturbed, as can be shown by means of voltmeters. The author shows how the readings of the voltmeters can be used to draw conclusions as to the changed insulation resistances. The results are especially interesting for three-phase systems.—*Atti,* November and December, 1909; *La Lumière Elec.,* April 16.

Insulated Cable.—A note on a recent British patent (11,135, 1909; April 21, 1910) of the British Insulated & Helsby Cables, Ltd., F. A. Cole and J. Shaw. The insulation consists of the following in succession: A thin layer of vulcanized rubber, a layer of vulcanized bitumen, another thin layer of vulcanized rubber, india-rubber coated tape, and finally, the braiding or other suitable covering. By thus interspersing the materials each protects the other from deleterious chemicals, and the rubber increases the mechanical strength and flexibility, preventing decentralization and cracking.—Lond. *Elec. Eng'ing,* April 28.

Contacts for Switchboards.—Roentsch.—An article illustrated by numerous diagrams on the usual methods of connecting conductors to a switchboard.—*Elek. Anz.,* April 10 and 17.

Electrophysics and Magnetism.

Alloy Steels.—S. Guggenheim.—An account of magnetic tests of silicon steels and silicon-nickel steels. For very high inductions silicon diminishes and nickel increases the permeability of the steel, but at the usual inductions an increasing amount of silicon increases very considerably the permeability while any addition of nickel has only a small effect. Steel containing more than 5 per cent of silicon is hard and brittle. The effect of silicon is shown in the following table in which *H* is the magnetizing force and *B* the magnetic induction:

H	BVII	BVIII	Percentage Increase
2	2,850	7,620	+168
5	8,350	11,660	+ 40
10	11,490	13,060	+ 14
20	13,670	13,860	+ 1.4
50	15,580	15,040	− 3.5
100	16,950	16,140	− 4.8

The induction *B* is given for two steels, one, *B VII,* containing only 0.184 per cent of silicon and the other, *B VIII,* 4.789 per cent of silicon. The fourth column gives the increase of the induction *B VIII* over *B VII* in per cents of *B VII.* It is seen that at very high inductions the increase of silicon content decreases the magnetic induction. The hysteresis losses increase up to 1.8 per cent of silicon and then decrease first quickly and later more slowly to a small amount at 4.5 per cent silicon. The hysteresis losses are smaller the higher the maxima of permeability. The steel *B VIII* has a loss coefficient of only 1.23 watt per kilogram compared with 1.85 watt per kilogram of German commercial steel.—*Bull., 3, Schweiz. Elek. Ver.,* 1910; abstracted in *Elek. und Masch.* (Vienna), April 17.

Iron Losses.—R. Czepek.—An account of experiments comparing the iron losses due to alternating single-phase magnetiza-

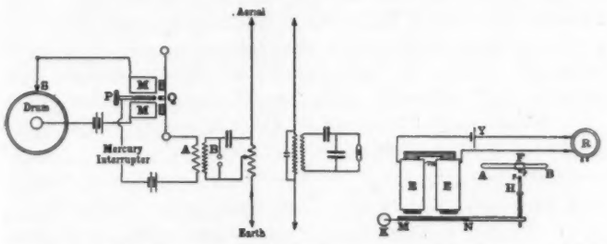
Induction B	Hysteresis Coefficient		Eddy-Current Coefficient	
	Alternating Magnetization	Rotary Magnetization	Alternating Magnetization	Rotary Magnetization
6,000	1.62	3.14	4.5	9.8
8,000	1.73	2.83	3.45	10.1
16,000	2.22	2.27	1.84	14.9

tion, rotary magnetization, and magneto-static magnetization. On the assumption that Steinmetz's empirical formula is applicable for both alternating single-phase and rotary magnetization, the following values of the hysteresis coefficient and of

the eddy-current coefficient for different inductions are found: —*Elek. und Masch.* (Vienna), April 17 and 24.

Telegraphy, Telephony and Signals.

Transmission of Photographs by Wireless Telegraphy.—T. THORNE BAKER.—A lecture delivered before the Royal Institution in London. The lecturer first described the telectrograph system as used by the *Daily Mirror*, explaining the method of overcoming the effect of capacity in the lines. He then referred to the work of Professor Korn with silenium cells, and finally gave particulars of the experiments in wireless transmission upon which the lecturer himself had recently been engaged. In the simplest form of demonstration apparatus a small electric lamp is coupled up with the local side of a relay and battery, the relay being actuated by means of a coherer detector. At the other side of the platform there is a Morse key, which, when depressed closes the primary circuit of an induction coil, the secondary being coupled up in the usual way to give oscillations. When one presses the key, and thereby sends a signal, the lamp at once lights up. If the coherer be tapped the lamp is extinguished and another tap of the Morse key causes it to light again. Now suppose that the taps of the Morse key were controlled by the lines in a photograph or sketch and that the light from the lamp were concentrated on a revolving photographic



Figs. 6 and 7—Circuits for Transmitting Photographs by Wireless.

film, it will be seen at once how a photograph could be transmitted by wireless telegraphy. Such a process would be utterly impracticable commercially, but the author's telectrographic system can be used with success in its place. A line picture is attached to the drum of the transmitter and the intermittent current, which is ordinarily passed into the telephone line, goes into an electromagnet (*M* in Fig. 6), which then attracts a soft-iron diaphragm attached to brass springs, which are fixed to two rigid supports. Every time electricity flows through the magnet coils this diaphragm is attracted to it, and the platinum contacts *PQ* are brought together; when the electricity flows, and *PQ* are in contact, the primary circuit of a transformer is closed and the secondary having a spark-gap and being inductively coupled to the aerial and earth, a signal is transmitted into space. Thus, in the wireless transmitter the only difference from ordinary telegraph lies in the fact that the length of the signals and their distance apart are regulated by the lines composing the sketch or photograph. The receiving apparatus is very simple, and depends, for short-distance work, upon a coherer cymoscope, the decoherer apparatus being of a particular character. Every time an oscillation passes to the antenna the coherer becomes conductive in the ordinary way and a relay is actuated; this relay is usually made to start a hammer vibrating, the hammer hitting the coherer, and thus causing it to lose its conductive power. However, a vibrating hammer is useless for the photo-telegraphic receiver, and it is essential to have only one strike on the coherer for each signal detected. The form of apparatus employed for this purpose is seen diagrammatically in Fig. 7. *EE* is the magnet which is actuated by the relay *R*. It then attracts an armature *MN*, which moves toward the magnet poles and brings a resilient hammer *H*, fitted with a platinum contact *P*, against the coherer. The coherer *AB* is also fitted with a collar *F* and contact pin, so that in the act of striking the coherer the hammer closes a local circuit, and thus causes a black mark to appear on the chemical paper. Successive distinct marks can be obtained in 0.017 second in this way. Only sketches of the simplest character are at present being transmitted. With wireless work the question of synchronism is serious, and the author describes two methods of synchronizing which he has employed with success.—Lond. *Electrician*, April 29.

Measurements for Wireless Telegraphy.—E. NESPER.—The conclusion of his paper illustrated by diagrams on the measurement of frequencies and wave-lengths in wireless telegraphy and telephony.—*Elek. und Masch.* (Vienna), April 17.

BOOK REVIEWS

ELECTRICITY FOR ENGINEERING STUDENTS. By H. M. Hobart B. Sc., M. Inst. C. E. New York: D. Van Nostrand Company. 207 pages, 115 ills. Price, $2.

This is a book that must not be judged by its main title, but rather by the subtitle which states that the work is intended for "engineering students." The subjects treated are so few in number and so technical in character that one is forced to conclude that Mr. Hobart's volume will appeal not so much to the student of electrical engineering as to the electrical engineer himself. This is equivalent to saying that the work will find its field of usefulness in the designing room of the engineer rather than in the classroom of the electrical student. The treatment is quite away from the beaten path, and every chapter contains data of high technical value.

VALVE SETTING. Simple Methods of Setting the Plain Slide Valve, Meyer Cut-Off, Corliss and Poppet Types. Compiled and written by Hubert E. Collins. New York: McGraw-Hill Book Company. 210 pages, 200 ills. Price, $2.

This book is based upon a number of articles giving information on the setting of valves. The author has filled in the space and produced a well-balanced and clear-cut treatment of valve setting which covers all reciprocating engines at present in use. The slide valve is very fully discussed, it being used to study the operation of steam engines. Those who master the slide valve will have little difficulty with the rest. Besides giving general methods of dealing with the different fundamental types of valves, a number of chapters are given up to the discussion of various valve motions, which differ in the details from the fundamental type. The book is well illustrated and indexed, and should be of value to all who are liable to be called upon to set valves of engines, pumps or compressors.

GARCKE'S MANUAL OF ELECTRICAL UNDERTAKINGS. Vol. XIV. Compiled under the direction of Emile Garcke. London: Electrical Press, Limited. 1774 pages. Price, 21s.

It would be impracticable to give an adequate description of a book of this nature in the limited space here available. Furthermore, the book now occupies such an important place in electrical, financial and business literature that this, the fourteenth edition, requires little more than the mere announcement that it is ready.

The classification remains the same as in previous years, namely: I. Electric Lighting, Power and Traction. II. Telegraphs and Telephones. III. Manufacturing and Miscellaneous. IV. Colonial and British Possessions. V. Directories of Officials, of Members of Electric Lighting and Tramway Committees, and of Electrical Contractors. VI. Index of Undertakings and list of other Electrical Undertakings registered since the year 1896. The main difference in the contents relates to the fifth division. The list of members of electric lighting and tramway committees has been considerably amplified, and will, therefore, prove even more valuable than formerly to manufacturers and others who desire to circularize the men who are responsible for the control of municipal electrical undertakings. An entirely new feature is the addition of a list of electrical contractors. The list is arranged under the heading of the town in which the contractors' premises are situated, the various towns being put in alphabetical order after London. Where possible the year in which the business was established is given, together

with the special line of business which each contractor takes up. A further facility for reference is given by placing branch establishments in italics and by marking with an asterisk those firms which belong to the Electrical Contractors' Association. The manual is devoted entirely to British interests within the United Kingdom and the British colonies. To those doing business in these countries the manual is invaluable.

Modern Progressive New Business Methods. Cleveland: Central Station Development Company. 239 pages, illustrated. Price, $1.

Perhaps the most notable central-station development of recent years has been the awakening of that industry to the importance of applying commercial methods in the sale of electrical energy. Formerly all interest centered in the engineering and operating sides, and the attainment of the highest efficiency and economy of generation appeared to be considered an end in itself. Perhaps the enjoyment in almost all cases of a monopoly of supply, with the lack of competition and disregard of the consumer which are apt to accompany such a status, accounts for the fact that up to a comparatively recent date commercial methods in the sale of electricity were almost entirely ignored by the great body of central stations. Even at the present day, the majority of plants are run along the old lines, but during the past few years the more enterprising managers have been brought to realize that in the sale of its output the central station has as distinctly a commercial side as any other line of business. The effect of the awakening has been remarkable, not only with respect to the expansion of business which has followed where the commercial idea has been introduced, and in the new vigor and confidence imparted to the electric lighting industry at large, but also in the rapid growth and systematization of what are popularly called "new business" methods. This latter development is well illustrated in the present volume, which not only gives in concrete form many hundreds of arguments to use in a "new business" campaign, but also explicit instructions as to their presentation by the solicitor, by circular letter, by booklet or in the advertising pages of newspapers. The author, Mr. W. H. Wissing, was one of the leaders in the application of commercial methods to the central-station business, and the details given in the work have either been tried out practically in successful work, or suggested by experience in such work. While the object of the book is primarily to exploit a definite and systematic means of central-station development, the work will be found of the highest interest by every central-station man.

The Popes and Sciences. The History of the Papal Relations to Science During the Middle Ages and Down to Our Own Times. By Dr. James J. Walsh. New York: Fordham University Press. 431 pages. Price, $2.

This work is largely the result of a controversy between President Andrew D. White and Dr. Walsh on the subject of the part played by the Roman Catholic Church in the development of science, one side of which question is presented by the former in his "History of the Welfare of Theology with Science in Christendom." The author regrets the controversial character of the book, but feels it his duty flatly to contradict certain notions which have gained widespread credence through the publications of men of high standing, though apparently ignorant of very many of the facts involved. In view of the dogmatic tone of such writers, the author can be pardoned the *ex-parte* presentation he makes of the other side of the case.

The author has obtained most of his facts at first hand from the original documents in possession of his church, and for this reason the work is of value not only to students of the controversial subject of the book, but also to all interested in the evolution of scientific ideas. It is, so far as we know, the first attempt that has been made to present from the Catholic standpoint fully and in compact form for the general reader the exact relation of the Roman Catholic Church to the development of modern science, and especially the development of the branches of anatomy, surgery and medicine.

The work naturally dwells on the intent and effect of the Bull of Pope Boniface VIII regarding the practice of dissecting for purposes of the study of anatomy. The author has made a translation of the famous decree and prints it in full, so that the reader can weigh the arguments for both sides in the light of the actual facts. The author throughout develops his thesis in a most interesting manner; the wealth of quotation from original documents and early writers is of great value and, moreover, assists the reader in forming conclusions of his own on controverted points. Many names connected with the history of the electrical science receive notice—Gilbert, Petrus Peregrinus, Albertus Magnus, Kircher, Paracelsus, Neckham, Vincent de Beauvais—in some cases accompanied with an interesting account of the writers and their work. It is said of Coulomb, Galvani, Volta, Ampere and Ohm that they were "not only members of the Church, but what can be called devout Catholics." Galvani, Volta and Ampere were members of the order of St. Francis, and the former insisted on being buried in the habit of the order.

In writing this book the author has performed a real service to the Roman Catholic Church by correcting the more or less general wrong impressions as to its attitude toward science in the middle ages. The misconception of the papal doctrine of infallibility by non-Catholics has led to much injustice toward that church, which should not be held responsible for utterances of churchmen on non-doctrinal questions, particularly when these merely reflect the relative ignorance—according to the modern view—common to the most enlightened men of the time when they were made. The graceful, yet vigorous literary style of the author makes the work one of sustained interest, and a book delightful to read, even by those who may not at times accept the writer's premises or conclusions.

The Thirteenth the Greatest of Centuries. By Dr. James J. Walsh. Second edition. New York: Catholic Summer School Press. 458 pages, 15 ills. Price, $2.50.

After an exhaustive study of the history of medicine and science in general, Dr. James J. Walsh has come to the somewhat startling conclusion that the thirteenth is the greatest of centuries, and in a book with that title, the second edition of which has recently appeared, he describes the conditions existing in that medieval age in the fields of education, science, arts, printing, music, literature, drama, law, medicine, etc.

During this century lived St. Thomas Aquinas, Albertus Magnus and his pupil, Friar Roger Bacon; the century witnessed the founding of nearly 20 universities; St. Francis and St. Dominic established their orders, and the signet of the Fisherman was worn by several of the greatest popes; St. Louis and Robert Bruce occupied thrones; the art of painting was revived, although in crude form, by Giotti and Ciambue, and that of literature splendidly re-established by Dante. Symonds has insisted that the Renaissance was not, as frequently assumed, a sudden awakening, but the climax of an intellectual movement extending through several preceding centuries, and the present book powerfully sustains this thesis.

In pedagogy, law, medicine, the fine arts and theological philosophy important movements are shown to have originated in the thirteenth century. In physical science some of our modern theories were anticipated, the result, however, rather of speculative thought than inductive method, though exception must be made in the case of the *Epistle* of Petrus Peregrinus and some of the work of Friar Bacon. Dr. Walsh points out that the theory of the constitution of matter as set forth by St. Thomas coincides with the latest theory as stated by Sir Oliver Lodge—not a very happy comparison in view of the prolific output of theories by the latter. The law of the conservation of energy was dimly recognized, and that of the indestructibility of matter specifically postulated by St. Thomas. Friar Bacon in his studies of explosives speculated on their possibilities, and anticipated the use to which they might some day be put in warfare. Further than this, he prophesied that some day explosive forces would be under absolute control and

might be applied in transportation, which last prophecy has been fulfilled in the gas and gasoline engine as applied to the automobile and motor boat.

Dr. Walsh points out that the status of the laborer seems to have been better in those days than at present. He was allowed freedom, and initiative was expected of him. Each vied with the other in the production of perfect work, with the result that most men were thoroughly interested in their tasks, which past Dr. Walsh contrasts with the present, when the workman is only a part of a system and performs certain mechanical operations day in and day out, his only interest being to earn money with which he may prepare himself for further labor on the morrow. This method naturally breeds discontent, and is cited as the principal source of our present-day labor troubles.

Dr. Walsh makes a thrust at the theory of evolution, which is challenged at least so far as it may present objection to the consideration of the thirteenth century as representing the highest stage in human accomplishment. Referring to the doctrine of evolution, Virchow is quoted as saying that after an exhaustive study of the skulls of the human race, extending back through a period of several thousand years, he failed to note any progress or development tending to prove the theory of evolution; and Dr. Walsh adds that history seems to back up this statement, recent discoveries showing that as far in the past as history carries us the human race has had much the same tendencies, and that laws for controlling communities were about the same in character as at the present day.

While the reader may well doubt if the title of the book is justified by its contents, Dr. Walsh has produced a most interesting and delightfully readable contribution to historical literature, and has especially performed a valuable service in clearly bringing out the actual status of a century which is usually entirely neglected or generally believed to be one in which little or no intellectual or material progress was made. The book is excellently printed and is illustrated by a number of plates giving views of church edifices dating back to the thirteenth century and reproductions of paintings of that period, including portraits of Dante and Boniface VIII by Giotti.

New Apparatus and Appliances

EXHIBITORS AT THE N. E. L. A. CONVENTION.

The exhibition committee of the National Electric Light Association announces that all of the available space at the Coliseum for the exhibition in connection with the thirty-third convention of the association in St. Louis, May 23-27, has been sold. A plan view of the exhibition hall, together with a list of the exhibitors and the location of their exhibits, is appended.

EXHIBITOR.	BOOTH.
Frank Adam Electric Co...	33
Allis-Chalmers Co.....	76-7-8
American District Steam Co.	48
American Elec. Heater Co.	7
American Z Elec. Lamp Co.	88
Anderson Carriage Co...	75½
Auto Maint. & Mfg. Co....	73
Baker Motor Vehicle Co..	58-9
Benjamin Elec. Mfg. Co....	55
H. B. Camp Co.....	54
Central Station Devel. Co.	91-2
Century Electric Co.....	38-9
Columbia Meter Co.....	69
Columbus Buggy Co.....	72
Crocker-Wheeler Co.....	50
D. & W. Fuse Co.....	62
Dearborn Drug & Chem. Co.	49
Diamond Rubber Co.....	1
Dossert & Co.....	82
Duncan Electric Mfg. Co..	90
Edison Storage Battery Co	81
Elec. Service Supplies Co.	61½
Elec. Storage Battery Co.	70-1
Electrical Record.....	56
Electrical Review.....	79
Electrical World.....	37
Federal Electric Co.....	8
Fibre Conduit Co.....	83
Fort Wayne Elec. Works..	80
G. & W. Elec. Specialty Co.	11
General Compressed Air & Vacuum Mach. Co.....	60
General Electric Co....	23-4-5
General Vehicle Co.....	26-7
Gudeman & Co.....	89
Hart Mfg. Co.....	28
Hubbard & Co.....	61
Hurley Machine Co.....	47½
H.W.Johns-Manville Co.	66-7-8
W. J. Jeandron.....	84
W. N. Matthews & Bro..	29-30
Metropolitan Eng'ing Co...	22
Minerallac Electric Co....	10
Moloney Electric Co...	41-2-3
Monolithic Conduit Co....	21
National Elec. Lamp Ass.	17-8-9
Otis Elevator Co.....	47
Phila. Elec. & Mfg. Co....	40
Pittsburgh Transformer Co.	9
Popular Electricity.....	52
Rauch & Lang Carriage Co.	74-5
Ricker Manufacturing Co...	5
Sangamo Electric Co.....	4
Simplex Elec. Heating Co.	2-3
Standard Underground Cable Co.	57
Star Electrical Concern....	6
Studebaker Bros. & Co.	85-6-7
Tungstolier Co.....	31
U. S. Light & Heating Co.	20
Wagner Elec. Mfg. Co.	34-5-6
Warner Arc Lamp Co.....	53
Waverley Co.....	32
Wesco Supply Co.....	44-5
Western Electric Co.....	63-4
Westinghouse Cos.....	12-3-4

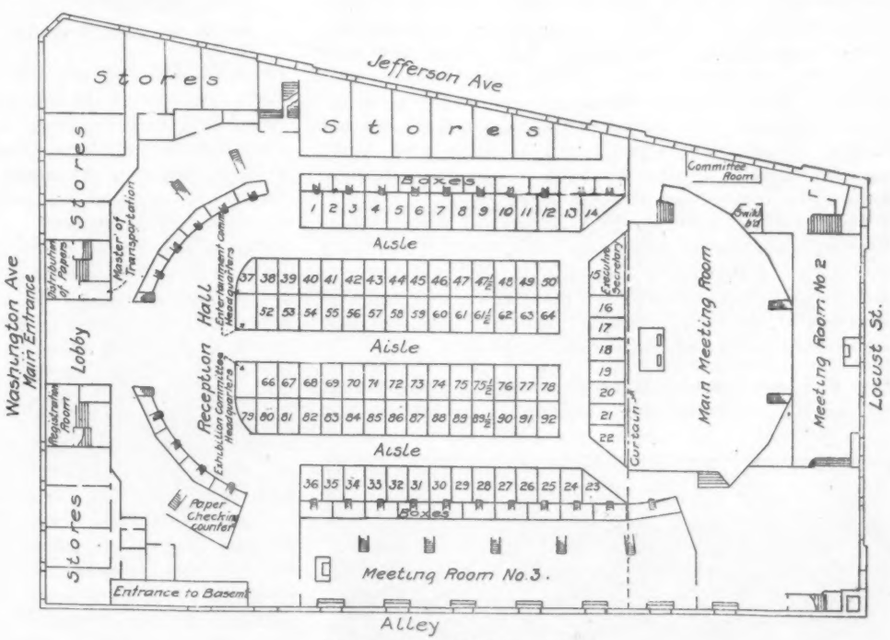


Diagram of Exhibition Hall.

Industrial St. Louis

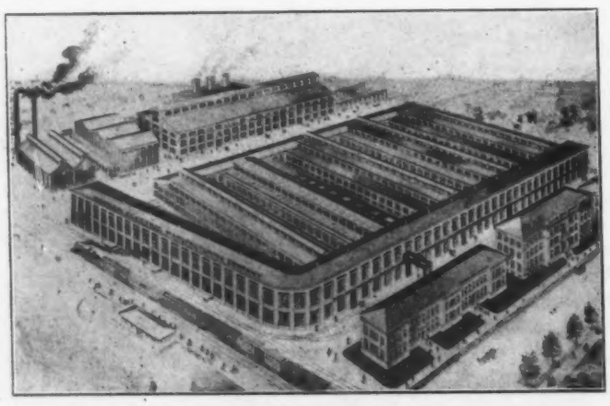
ST. LOUIS AS AN ELECTRICAL BUSINESS CENTER.

WHEN in 1764 Laclede and Chouteau founded the fur-trading post of St. Louis, now the fourth city of the United States, they builded better than they knew. The largest city west of the Mississippi, and nearest the geographical center of the country, St. Louis, with the vast territory tributary to it, has manifest and conspicuous advantages. This strategic situation has been realized by electrical as well as other business interests, and through the channels of St. Louis electrical supply houses flows a great stream of electrical goods. At the same time the electrical manufactures of the city are not limited in their geographical distribution to any locality, for appliances and machinery bearing the St. Louis mark go to every part of the United States and find sales in many foreign countries.

The total volume of electrical business done in a year in St. Louis is placed at about $15,000,000, of which amount probably $5,000,000 worth is actually manufactured in the local factories, the remaining $10,000,000 representing merchandise and products passing through the city. The electrical merchandise sales made in St. Louis, but shipped from other points, amount to about $5,000,000. Approximately, 2500 people are employed by the electrical industries of the city—about 75 electrical concerns (including foreign manufacturers who maintain local offices) doing business in St. Louis. The total investment in electrical manufacturing corporations is about $5,000,000.

In reviewing the above figures it is also interesting to note that the volume of electrical business of St. Louis is increasing very rapidly. Especially is this true of the local electrical manufacturing business, which five years ago constituted only 10 per cent of the total volume of electrical trade, but now amounts to about one-third, and continues to grow.

The Wagner Electric Manufacturing Company is the largest of St. Louis electrical industries. The modern and extensive manufacturing plant of this company is located on the main line of the Wabash Railroad at Plymouth Avenue, and comprises seven buildings covering 85,000 sq. ft. of ground space on the plant property of 14 acres. The layout of this new plant is representative of the most advanced manufacturing methods, as well as of the most approved consideration for employees, for whose comfort there is supplied a special, large, three-story "service" building. The four-story administration building, the transformer shops, punch shops, motor shops, store building and the power plant make up the remainder of the present structures, provision having been made for the future enlargement of the various departments as needed. The Wagner Company was founded in 1890 by H. A. Wagner and Ferdinand Schwedtman, who began the manufacture of alternating-current fan motors in a small way. Later the manufacture of transformers was added and meanwhile the shops of the company outgrew one building after another. Other lines entered were the making of direct-current motors and generators, and the manufacture of electrical instruments, while the name of the Wagner Company will always be associated with the introduction of the first successful single-phase alternating-current motor. Emphasis has been placed always on the high quality of the output, and the growth of the Wagner business has attested the sound and progressive character of its methods and products.



Works of Wagner Electric Manufacturing Co.

Mr. S. M. Dodd, President.

One of the forceful characters associated with the electrical interests and industries in St. Louis, and, in fact, with the growth and welfare of St. Louis irrespective of any special industry, is Mr. Samuel Morris Dodd, chairman of the Board of Directors of the Wagner Electric Manufacturing Company. Within recent years Mr. Dodd has severed his active connection with many of the corporations with which he has been identified in St. Louis for the past 50 years and more. He continues, however, as chairman of the board of directors of the Wagner Company, a director of the National Bank of Commerce, St. Louis' largest financial institution, enjoying the distinction of the longest service as a director of this institution; treasurer and chairman of the Finance Committee of the American Central Insurance Company, one of the leading fire insurance companies of the West, and in fact of the country; and a director of the Commonwealth Trust Company and Title Guaranty Trust Company. Mr. Dodd organized and for many years headed the Missouri Edison Electric Company, retiring from its management when that company was sold to the

Mr. W. A. Layman, Vice-President and General Manager.

North American Company. It was the urgent need of the Missouri Electric Light & Power Company for better distributing transformers back in 1891 that led Mr. Dodd and some other officers and stockholders of that corporation to lend their support to Mr. A. H. Wagner and his associates in extending their manufacturing business into the field of transformer work, which led to the formation of the Wagner Electric Mfg. Company with an initial capital of $25,000. Mr. Dodd agreed to "father" the little company and become its first president. He has continued with it ever since, guiding it through the vicissitudes to which all new companies have always been and always will continue to be exposed to the present point of importance and stability, which is expressed best by the statement that the Wagner Company to-day is fourth in size of the companies manufacturing electrical machinery in this country.

The officers of the Wagner Company are: President, Mr. S. M. Dodd; vice-president and general manager, Mr. W. A. Layman; second vice-president, Mr. J. W. Bell; treasurer, Mr. W. S. Thomas; assistant general manager, Mr. W. Robbins; chief engineer, Mr. A. H. Timmerman; superintendent, Mr. C. B. Lord. The Wagner Electric Manufacturing Company is capitalized at $1,200,000, and many offices are maintained in other cities.

The Emerson Electric Manufacturing Company occupies a large, modern six-story factory building at Washington Avenue and Twentieth Street where it carries on the manufacture of its well-known alternating-current and direct-current motors in fractional horse-power sizes and desk and ceiling fans. This company has become a specialist in the design and construction of small motors, building no machines rated above ½ hp. Its products are shipped to all parts of the United States, and are exported abroad, large consignments going to South America. The Emerson Company was organized in 1890. Its present officers are: President, Mr. H. L. Parker; first vice-president, Mr. C. R. Meston; second vice-president, Mr. T. M. Meston, and secretary, Mr. L. L. Whittemore.

The Columbia Incandescent Lamp Company, whose main office and works are on Locust Street, near Twenty-first Street, manufactures the lion's share of the several million incandescent lamps made in St. Louis yearly. These lamps include the carbon-filament, graphitized-filament, tantalum and Mazda types, and are distributed from Maine to California and from Canada to Mexico. The company maintains sales offices in Boston, New York, Philadelphia, Minneapolis, Memphis, Dallas, Denver and San Francisco, where large stocks are carried. The Columbia Incandescent Lamp Company was organized in July, 1889, and was incorporated in 1890, at which time it was located at 519 Elm Street, St. Louis, and later at 1910 Olive Street. Its present modern factory on Locust Street was first occupied in January, 1903. The officers of the company are: President, Mr. A. C. Garrison; vice-president, Mr. D. E. Garrison, and secretary, Mr. F. H. Blackburn.

Mr. A. C. Garrison, President.

The Century Electric Company occupies a large, five-story, modern factory building at Nineteenth and Olive Streets, which was especially constructed for its manufacturing needs and is fitted with electric drive throughout. The company manufactures single-phase, alternating-current motors of from ¼ hp to 40 hp, and for frequencies of from 25 cycles to 140 cycles, besides building a limited number of alternating-current ceiling fans. Its motors are built in the horizontal, vertical and back-geared types. The Century Electric Company began operation in October, 1904. Its present officers are: President, Mr. James F. Coyle; vice-president, Mr. E. S. Pillsbury; secretary, Mr. R. J. Russell, and treasurer, Mr. John Heiget. These, with Mr. Senter M. Jones and Mr. H. M. Brinsmade, constitute the board of directors of the company.

The Moloney Electric Company, at Seventh and Hickory Streets, has a commodious factory building devoted to the manufacture of transformers of all types, from the smallest sizes of potential devices up to heavy apparatus of 5000 kva rating, and for voltages as high as 100,000. The Moloney Company has been a pioneer in the use of the new high-efficiency non-ageing transformer steels, thereby minimizing the all-day losses of its products in service. The company first began business in 1897 and early determined upon the construction of core-type apparatus as possessing superior inherent advantages of design. The officers of the company are: President, Mr. T. O. Moloney; vice-president, Mr. J. J. Mullen, and secretary, Mr. H. Wurdack.

Mr. T. O. Moloney, President.

The Wesco Supply Company was organized in 1903, when it took over the business of the Western Electrical Supply Company, which first began operations in 1891. The principal offices and warehouses of the company are at Seventh and Clark Streets, and Eighth and Clark Streets, St. Louis, other large branch houses being located at Ft. Worth, Tex., and Birmingham, Ala. The large sales organization of the company covers the United States west of the Mississippi and south of the Ohio, and the Republic of Mexico. The Wesco Company is general distributing agent for rubber-covered wires and cables, weatherproof and bare wires, electrical machinery, arc lamps, incandescent lamps, meters, transformers, etc., and also manufactures telephones and telephone switchboards. The officers of the company are: President, Mr. C. R. Scudder; vice-president and general manager, Mr. R. V. Scudder; treasurer, Mr. A. M. Wood, and secretary, Mr. Charles Scudder, Jr.

The Commercial Electrical Supply Company occupies its own modern building at Fifteenth and Pine Streets, where, with its warehouse, it has an available floor space of about 70,000 sq. ft. Besides its complete general supply business, the Commercial Company has specially manufactured for it the following articles bearing its name: Carbon and tungsten incandescent lamps, direct-current motors, fan motors, friction tape, soldering compounds, fixtures, insulators, and telephones and telephone switchboards. The company distributes over a large territory, embracing the Central West and Southern States. The present organization of the Commercial Company has been in effect since 1899. The officers are: President and treasurer, Mr. L. T. Nolker; vice-president, Mr. W. H. Nolker, and secretary, Mr. R. E. Nolker.

The Frank Adam Electric Company was a pioneer organization in the St. Louis electrical field, having been established in 1870 for the manufacture and installation of such electrical appliances as were then in use. At the present time the company builds switchboards of all kinds, switches, cabinets and boxes, and deals in electrical supplies, heating devices and cooking utensils. Its products are distributed throughout the United States, a large share, however, going into the Southwest and to the Pacific Coast. It has also installed switchboards in a large number of United States post office buildings. Mr. Frank Adams is president and treasurer, and Mr. Fred B. Adam is secretary of the company.

Arthur S. Partridge, who is a native of St. Louis, has been engaged for the last 20 years in that city in the general street-railway supply, car, electrical and steam-machinery business. Mr. Partridge's business has grown until it covers second-

hand apparatus of all kinds from 1500-kw units down. A large number of orders have been taken for complete railway and central-station equipments. Mr. Partridge has offices in the New Bank of Commerce Building, Broadway and Pine Streets, where he will be glad to meet his friends during the convention. Mr. Harold R. Wilson, who is manager of Mr. Partridge's electrical and steam departments, has had a wide range of experience in business of this character.

W. N. Matthews & Brother have their principal office and storeroom at 219 North Second Street, maintaining sales offices in New York, Chicago and San Francisco, as the special appliances of this company are in demand in all parts of the world. Among the "patented money-saving specialties" of which this firm is sole distributor, are guy anchors, cable clamps, splicing joints, rollers, lamp guards, sleet cutters, cord adjusters, lamp changers and reflectors, which are sold largely through jobbers. The firm was organized in 1899 and is a partnership composed of Mr. W. N. Matthews and Mr. Claude L. Matthews.

Mr. W. N. Matthews.

The St. Louis Electric Heating Company has recently moved into its new factory, 75 ft. x 150 ft., at 4414 Papin Street, where it will continue on an enlarged scale the manufacture of "Peacemaker" electric irons and heating devices. These electric irons are made in sizes weighing from 3 lb. to 27 lb., and are characterized by the simplicity and ruggedness of their wire-wound heating element. The company was organized in 1907 and is expanding rapidly under its own headway. Mr. B. S. Adams is president, Mr. J. A. Howze is vice-president and treasurer, and Mr. R. F. Lund is secretary.

The Central Telephone & Electric Company until recently devoted itself to the manufacture and sale of telephone apparatus, but in 1909 added general electrical supplies and specialties, being now distributors of electric-light material of all kinds for the South and West. A branch warehouse is maintained at Dallas, Tex. The company controls and manufactures a successful tungsten adapter. The officers are: President, Mr. James Cuming; vice-president, Mr. C. H. Wallis, and secretary, Mr. L. R. Brandewiede.

The United Electric & Supply Company does a general jobbing business throughout St. Louis and the Southwest, carrying a large stock at 1120 Pine Street. The company is also exclusive agent for certain fixtures, and fans and flame arcs. In 1909 the United Company purchased the Ewing-Merkle Electric Company, with which it combined. Mr. H. Sikemeier is president, and Mr. C. E. Vail is secretary.

The International Supply & Export Company, whose offices are in the Bank of Commerce Building, deals in mechanical and electrical machinery and supplies, and designs power plants, lighting fixtures, etc. It is the manufacturer of a system of concealed lighting for banks, public buildings, etc. The International Company also acts as agent for a number of out-of-town manufacturers. Mr. Oliver Shiras is president of the company.

The Electric Traction Supply Company, 310 Market Street, manufactures and deals in electric lighting and railway materials. The company caters largely to outside construction in electric lighting, as well as supplying incandescent lamps, arc-lamps, carbons, etc. The present organization was incorporated in 1905, after having been in business since 1902. Mr. O. W. Uthoff is president and treasurer, Mr. Abe Cook is vice-president, and Mr. W. E. Fissee is counselor.

The William Wurdack Electric Manufacturing Company's factory and office are located at 19 South Eleventh Street, where special designs and standard constructions of switchboards and apparatus of all kinds are built, and other specialties manufactured on a less extensive scale. Mr William Wurdack is the active president and manager of the company.

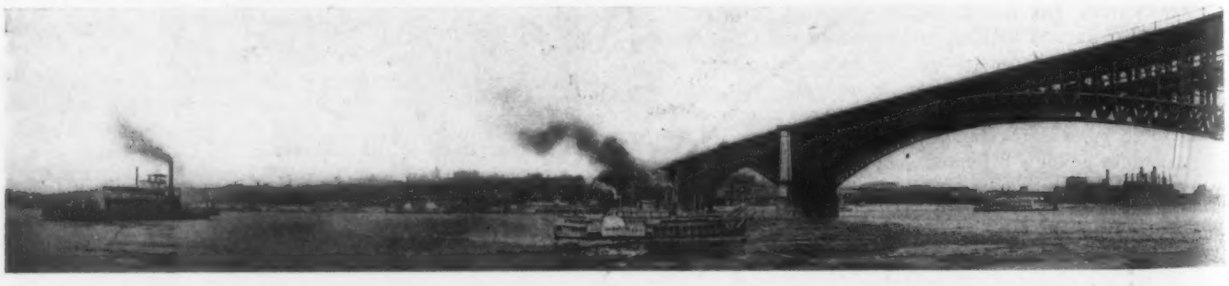
The United States Incandescent Lamp Company, manufacturer of incandescent lamps, has its factory at 201 and 203 Jefferson Avenue, and maintains its general office in the Merchants'-Laclede Building. Mr. H. G. Ferguson is president and proprietor of the company, and Mr. R. W. Ferguson is manager of works.

The American Carbon & Battery Company's extensive plant for the manufacture of graphite and carbon products is located at Signal Hill, East St. Louis, Ill., where electric railway and freight service is available for the transportation of raw and finished material. The American Carbon & Battery Company was organized in St. Louis in 1900, succeeding the old Booker Carbon Company; and removed to its present location in 1905. It manufactures carbon and graphite brushes, carbon electrodes, battery supplies, carbon flour, and carbon specialties. Mr. Henry Wrape is president, and Mr. Harold J. Wrape is secretary of the company.

The Southern Illinois Electric Company is located in East St. Louis, and carries a complete general line of electrical supplies and specialties for the Western and Southern territories. It is also the manufacturer and distributor of the American vibrator device. The company has been in business two years. Its officers are: President, Mr. H. G. Paro; vice-president, Mr. B. V. Chase, and secretary and treasurer, Mr. H. M. Bean.

In addition to the local electrical manufacturing and supply concerns above mentioned, most of the large electrical companies of the country maintain offices in St. Louis. Several of these, including the Western Electric Company, the Westinghouse Electric & Manufacturing Company, and the H. W. Johns-Manville Company, have important warehouses. The General Electric Company has a local office, but supplies the St. Louis territory from its Chicago and Kansas City warehouses.

In an allied electrical field, that of the street railway, it may be noted that approximately $3,500,000 worth of electric-railway cars are manufactured in St. Louis each year, the local plant of the St. Louis Car Company being one of the largest car factories in this country.



THE CONSTRUCTION AND OPERATION OF AN AMERICAN FLAMING-ARC LAMP.

BY L. J. AUERBACHER.

It is now five years since the flaming-arc lamp was commercially introduced into the United States, and owing to its high efficiency it has developed a large field of usefulness. The first flaming-arc lamps imported, possessed a differential clockwork mechanism, and the natural prejudice against all clockwork mechanism militated against their rapid introduction. One of the most radical and practical improvements recently made in

Fig. 1—Mechanism of Hawthorn Flaming Arc Lamp.

flaming-arc lamp design is a method of feeding the lamp without the use of differential mechanism.

In flaming-arc lamps of this type, an electrode is held by a metal support at the arc, and the gradual burning away of the electrode allows it to sink down slowly and maintain the arc. This basic principle has done much to eliminate the prejudice formerly held against flaming-arc lamps owing to their complicated construction. Notwithstanding the simplicity of this construction it took several years to develop a commercial lamp

Fig. 2—Hawthorn Flaming Arc Lamp.

which was dependable in operation. An American lamp which embodies these principles has been placed on the market by the Western Electric Company and is known as the Hawthorn flaming-arc lamp.

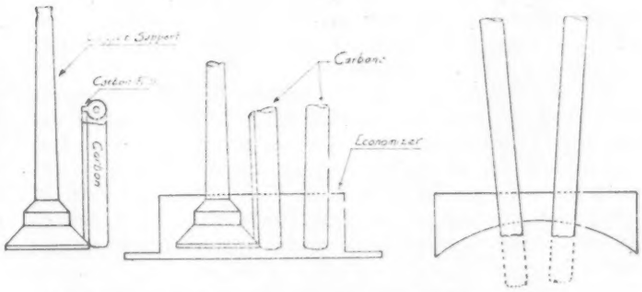
Fig. 1 shows the lamp mechanism. When the circuit is closed a series magnet is energized, which operates a pantograph lever and pulls the electrodes apart in a parallel position. In the direct-current lamp the negative electrode has a rib or projection on one side which rests on the copper support shown in Fig. 3.

In this lamp two paths are provided for the flow of energy; one through the copper support and the other through the electrode holder, thus offsetting the resistance of the carbon electrode and at the same time assisting in burning away the rib support of the negative electrode.

The principle underlying this lamp is that the carbon electrode is cooled at a point furthest away from the arc by reason of its resting on the copper support, thereby disintegrating gradually without injury to the support. These copper supports become charred in time and should be renewed every three to six months. They cost only a few cents and are really the safety valve of the lamp, in which the trouble, if any, concentrates. The trimmer can renew one without any difficulty and lamps unless injured mechanically do not have to go to the shop.

A dash pot is attached to the solenoid core to prevent the too rapid pulling apart of the electrodes. No shunt coils are necessary and a complicated train of gears, star wheel and other adjustments are not required. The lamps operate under all usual service conditions and can be connected two in series on 110-volt circuits as well as four in series on 220-volt circuits. When four or more lamps are run in series, an automatic cut-out is mounted in the lamp, together with a substantial resistor. When any lamp of a series is cut out, the circuit is automatically closed through the resistor, and the equilibrium and other characteristics of the circuit maintained.

This type of lamp has been very successful on 25-cycle rail-



Figs. 3, 4 and 5—Copper Supports and Economizer.

way circuits, having wide voltage fluctuations, which clearly indicates that the rib-carbon-supporter feed is very efficient. Another feature of this type of feed is the fact that the arc is always in a fixed position with reference to the economizer, as shown in Fig. 4. This is important, as the amount of oxygen which the arc gets is always about the same, due to the cushion of gases given off by the electrodes.

It has been noticed that in differential arc lamps slight inequalities of feed or variations of voltage will often cause the lamp to tend to feed the electrodes down too fast, so that they are in a position indicated by the dotted lines in Fig. 5. Consequently there is an excess of oxygen, which tends to cause the electrodes to consume away very fast. This explains why with even normal ampere readings 600-mm carbon electrodes rated at 17 hours will in actual practice often only burn as long as 10 hours.

The Hawthorn flaming-arc lamp, in addition to using this modern and simple feed, has other features of construction which should appeal to the engineer. All parts are heavy and well nickeled. The electrode holders are substantial and will stand the abuses to which the average trimmer subjects them. The paraboloid globe used gives the best distribution, tending to increase the horizontal candle-power. The case is heavy and the catches are substantial and easily handled. Lamps burn normally at 10 amp, two in series, on 100-volt to 120-volt circuits, consuming about 550 watts and giving a mean lower hemispherical candle-power of 2800.

THE POWER PLANT OF THE MARBRIDGE BUILDING, NEW YORK CITY.

By D. H. Braymer.

Among the store and office buildings which have recently been built in New York City after the latest and most improved design, the Marbridge Building is a noteworthy example. This structure is located at Broadway and Thirty-fourth Street,

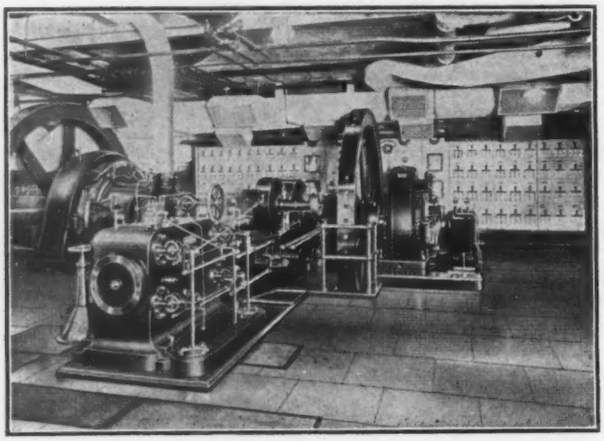


Fig. 1—Engine Room.

and serving as it does various interests, the electrical equipment is most diverse and complete.

The power plant of the Marbridge Building is located in the sub-basement and has been in operation since May 1, 1908. The load curve herewith indicates in a general way the nature of the load which is carried.

The electrical generating plant consists of three engine-type Hawthorn generators, direct-connected to Rice & Sergeant single non-condensing engines. Two of the units are rated at 300 kw and one at 100 kw. All operate at 100 r.p.m. at full load and not over 102 r.p.m. at no load. The engines are of the heavy-duty type and at about one-quarter cut off develop 465 hp and 160 ihp under the conditions of steam pressure maintained, which is 110 lb.

The engines are well regulated by an inertia governor driven by a belt from the shaft. A 2 per cent regulation is maintained from no load to full load, and the governor is so arranged that it will shut off steam to the cylinder should anything happen to the driving belt. The bearings are made up with wedge adjustments and are self-oiled. The engines, including valve gear and dash-pots, operate without vibration and are practically noiseless.

The generators are standard Hawthorn, direct-current machines, manufactured by the Western Electric Company, and are of a design and construction which enable them to withstand severe operating conditions.

The pole pieces are built up of thin sheets of thoroughly annealed mild steel riveted and bolted together. Any chance of unequal magnetic distribution, with the attending sparking, which is so distasteful to the operating engineers and so detrimental to brushes and commutator is taken care of by the manner in which the pole pieces are secured in the frame. The frames are cast around the jagged ends of the pole pieces, securing a partial weld and a consequent excellent magnetic contact.

The mechanical and electrical details of the armature of the generators are of a very careful design. Iron losses are reduced to a minimum by carefully annealing the laminated disks of the armature core and providing special ventilation space to allow a thorough system of ventilation. The armature is wound with solid bars of copper formed into coils and enlarged in cross-section at the ends of the armature, thus obtaining low armature resistance and a consequent gain in efficiency at high-load points. Due to this construction a low temperature rise is insured and the ability of the machines to stand considerable abuse is provided for.

The commutators are of a very rigid construction. Segment insulation and ventilation systems are taken care of in a thorough manner, the mica used, being especially prepared, is of a sufficient degree of hardness to produce a uniform wearing commutator surface. The brush holders have a special mounting on a circular ring which is supported from the yoke and moved around the commutator by hand wheel making adjustment easy. Tension of the springs is protected by not allowing current to pass through any sliding contacts.

The generating plant, as well as the other distribution throughout the building, is controlled primarily at the switchboard located in the engine-room and shown in Fig .1. This board is of Tennessee marble and is made in three sections composed of 11 panels, it is approximately 31 ft. long, and is thoroughly supplied with both registering and indicating meters and with all the usual service and safety devices. From this board, feeders, of which there are 51, radiate to distribution centers located on the different floors. The circuits are arranged for a three-wire distributing system and the feeders are of ample current-carrying capacity to insure a low drop in transmission. The lighting scheme is worked out so as to embrace the use of arc lamps, carbon-filament, incandescent and metallized-filament lamps. There are throughout the building approximately 6500 outlets.

The secondary or low-voltage equipment comprises a watchman's time-detector system, fire-alarm system, electrical sprinkler system, call-bell and annunciator system. The locations of the outlets for the first three systems have been arranged with the idea of absolute electrical protection against fire.

The heating and ventilating equipment of this building is among the most complete of its kind for store and office purposes. The building is heated entirely by steam, the exhaust steam from the power plant being utilized for this purpose. Automatic heat control, installed by the Johnson Service Company, is provided for the control of all indirect stacks and all radiators in the basement, ground floor and the bushel-room on the second floor, also for control of the temperature of the fresh-air supply for the ventilation.

With the exception of the minor quantity of the air supply,

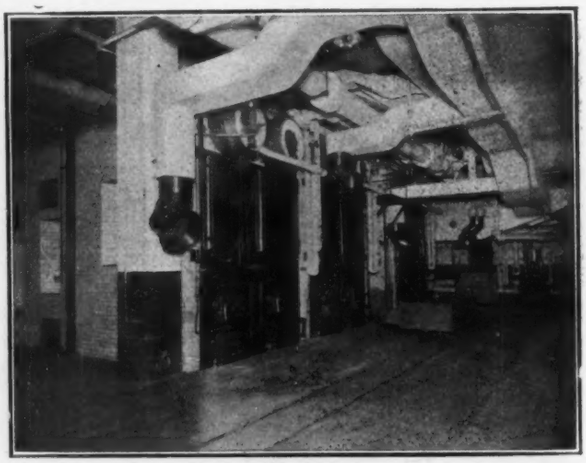


Fig. 2—Boiler Room.

at times passed over the indirect stacks for supplementary heating of the ground floor, the ventilating system is entirely independent of the heating system. The ventilating apparatus consists of six steel-plate centrifugal fans, four of 8-ft. diameter and two of 9-ft. diameter and two 5-ft. Blackman-type disk fans. The ventilating fans are all driven by direct-connected slow-speed electric motors, each fan having its independent motor, with the exception of the two air-supply fans

for the basement and ground floor, which are connected on one shaft and driven by one motor.

Steam for all purposes is generated by three boilers, of the wrought-steel header type, of the Babcock & Wilcox manufacture, having an aggregate of 8000 sq. ft. of heating surface and 179 sq. ft. of grate surface. All steam pipes 4 ft. in diameter and over subjected to boiler pressure have Van Stone flange joints, with extra heavy rolled weldless steel flanges, and all smaller steam pipes subjected to the same pressure are extra strong wrought-iron pipe. All fittings of these pipes are extra heavy and made of gun iron.

The steam piping supplying the generator, engines, elevator

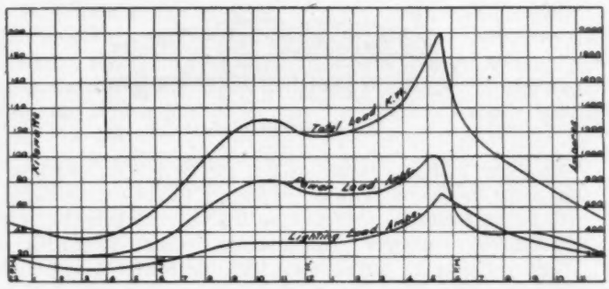


Fig. 3—Load Curves, Marbridge Plant.

pumps, and all other principal appurtenances, are in duplicate. Auxiliary mains have been provided throughout. The exhaust is conveyed to the heating system, the hot-water heaters and the free exhaust pipe leading to the roof. All water of condensation, together with the make-up water for the boiler feed, is passed through a Utility feed-water heater and eventually is pumped into the boilers. The Paul air-line vacuum system is installed in connection with the heating apparatus, tempering coils of the ventilating apparatus and the hot-water heaters for the plumbing system, thus permitting a rapid steam circulation in these systems, with a minimum back pressure on the engines and the other steam-driven appurtenances.

The energy delivered at the switchboard of this plant is developed at the lowest cost. By means of the McClave shaking grate a very heavy fire is burned and the greatest efficiency of the boiler is realized. A high grade of coal is used and by

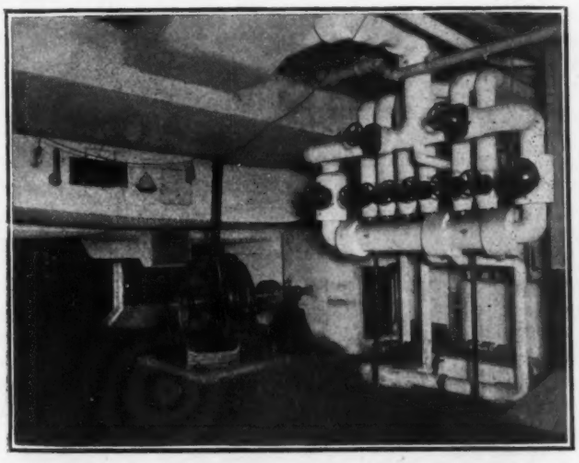


Fig. 4—Ventilating Fan and Duct.

expert stoking the per cent of coal in ash is kept very low. Friction is reduced to the lowest possible amount by means of a special oiling system, furnishing all bearings of engines and generators with a constant supply of cool filtered oil.

The working out of the entire equipment of the Marbridge Building power plant is largely due to the efficient organization and careful attention given to all the operating details. The chief engineer and superintendent is Mr. W. R. Thompson. The electrical equipment, with the exception of a few motors, was furnished and installed by the Western Electric Company. The heating and ventilating apparatus, the steam boilers, steam piping and all steam appurtenances were installed by Messrs. Geo. A. Suter & Company from plans and specifications prepared by the late Alfred R. Wolff, under the direct charge of Mr. Werner Nygren, of Nygren, Tenney & Ohmes, Mr. Wolff's successors.

SHOCK ABSORBER AND ADAPTER FOR TUNGSTEN LAMPS.

The Dale Company, New York City, is the manufacturer of the combined shock absorber and adapter for tungsten lamps illustrated herewith. The device consists of a link joint inter-

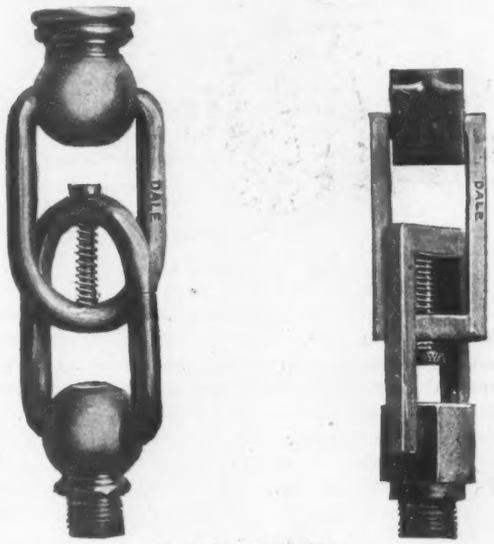


Fig. 1—Shock Absorber.

posed between the lamp socket and the fixture in which a spring and pin are incorporated. The pin is firmly attached to one of the links and is free to move through the other link, both links

Fig. 2—Applications of Shock Absorber and Adapter.

being held apart by the tension of the helical spring which surrounds the pin. It is evident, therefore, that any shock or jar which the chandelier receives is not transmitted to the lamp in the socket, but is absorbed by the spring and links. The swivel feature makes the device also applicable as an adapter on fixtures fitted with lamps set at an angle. The application of the device for both purposes is illustrated in Fig. 2.

TUNGSTEN STREET LAMP FIXTURE.

The Benjamin Electric Manufacturing Company, of Chicago, is placing on the market a new fixture, the purpose of which is to secure a maximum efficiency in street lighting with series tungsten lamps. This result is accomplished by means of a reflector designed to project the larger portion of the light in the direction of the street instead of permitting it to radiate equally throughout the usual 360 deg. The device consists of a large porcelain socket with integrally formed knobs, a short-circuiting device and a film cut-out which is removable at will

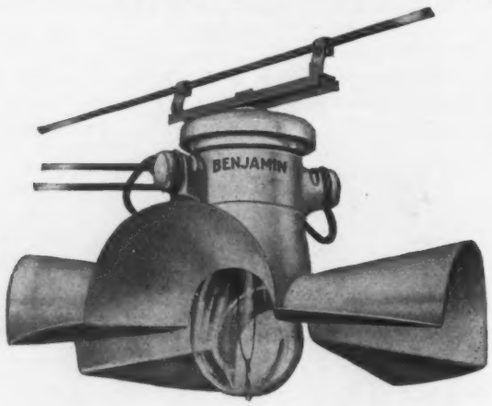


Fig. 1—Parabolic Reflector.

with the lower portion of the socket, and a supporting casting, tapped for ¾-in. pipe. The live portions are thoroughly insulated from the support by the porcelain socket and a petticoat porcelain insulator. The socket is provided with hooded grooves below the insulator for receiving the wires. Connections are made with the socket terminals by means of heavy clamping plates set at an angle, thus permitting ready access and insuring good contact. Two forms of reflector are regularly furnished: An 18-in. porcelain enameled steel reflector

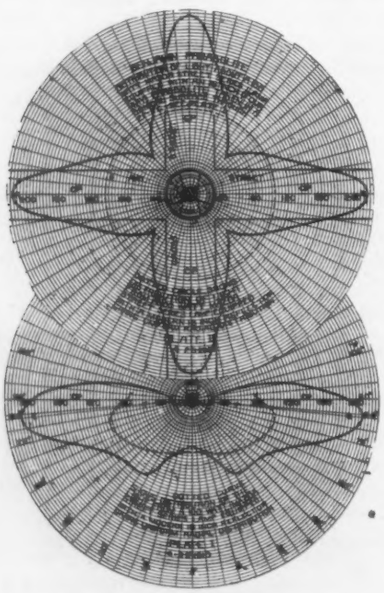


Fig. 2—Distribution Curves.

formed in four half parabolas, the purpose being to concentrate a maximum portion of the light in the direction of the street while furnishing a sufficient amount of light for the street intersection; and a second form of reflector designed to throw the light in two directions in the middle of the block. A third form is nearly flat. The device is also made with 36-in. gooseneck of ¾-in. galvanized iron pipe, and can be had with substantial steel lamp guard. Apart from the results in the distribution of light, the compactness of its structure with resulting strength, the acessibility of its parts for repairs, and the security of its connections are prominent features of the fixture.

WIRE GRIP.

A new wire grip has been placed on the market by Mathias Klein & Sons, Chicago, Ill., to handle No. 10 insulated wire. "Chicago" grips for the larger sizes from No. 4 to No. 4-0 have been on the market for some time, but none for No. 10

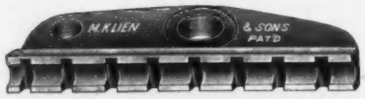


Fig. 1—Detail of Grip.

wire. The peculiar feature of this grip is the construction of the upper or sliding jaw. By reference to the enlarged cut, it will be seen that it is divided up into intermittent flat spaces and transverse grooves. The effect on the wire is such that the pressure due to the pull causes a slight depression in the insulation where in contact with the flat spaces, and presses it slightly into the transverse grooves just sufficient to grip tightly and prevent slipping without injuring the insulation in the least.

Fig. 2—Wire Grip.

The lower jaw is simply provided with a longitudinal groove having an extension lip along its side as a firm support around a large part of the body of the wire. A feature in all of the "Chicago" grips is the arrangement of the drawlink in a way that it does not hang down at right angles, and therefore is not in the way of the line wire when the grip is put on. The loop never drops below the horizontal position shown in the cut, but is free to move upward. This feature is appreciated when it is necessary to reach far out on the wire to put on the grip in pulling in slack.

THE HIGH-EFFICIENCY-CARBON LAMP.

The member companies of the National Electric Lamp Association have instituted and are carrying out a vigorous campaign to introduce high-efficiency carbon lamps. Following is the problem and the means offered for its solution:

In the majority of cases the light furnished by the old 3.5-watt carbon lamps has not given satisfaction. The customer complains that his bills are too high, that his light is not good enough, and his lamps do not give sufficient light. Even though the customer may be satisfied at the start, he is sure to kick before long, for, although his bills run along about the same, his light gets dimmer and dimmer. He doesn't know why and complains about the poor service, while all the time the fault is not with the service, but with the lamps, which have outlived their useful existence. New lamps should replace old, but this is seldom, if ever, done until the lamp actually burns out. There are two solutions:

A higher efficiency carbon lamp, the 50-watt (top voltage), which corresponds to what was the 16-cp, 3.1-watt lamp, greatly reduces the long period of between 2000 and 4000 hours when the old lamp, before burning out, delivers a thoroughly unsatisfactory light and makes dissatisfied customers. A higher efficiency carbon lamp would go a long way toward improving the general standard of light and lighting efficiency. It would better the

load factor, level the peak, and fill the day load by the increased use of flatirons, fans and heating devices installed by both new and old customers.

A 50-watt, top-voltage lamp will deliver light of better color value than the lower efficiency lamp at botom or middle voltage. Low voltage and small feeders are not at fault in most cases where poor light is delivered, but where they are, the use of a lamp of higher efficiency, such as the 50-watt (top voltage) lamp, would tend to improve the situation. Lamps of this type will slightly lower the load, it is true, but will deliver better light than is now prevalent, tending toward more frequent renewals and a consequent better average illumination.

The 60-watt lamp (top voltage), at the same price, would appear to meet conditions better than the 50-watt (top voltage). Not only does the former give 25 per cent more light than the old style 16-cp, 3.5-watt lamp, but the increase of 4 watts per lamp would warrant its use on the central-station circuits, where the rates do not permit the use of the mazda lamp. The use

Nominal Watts	Voltage	Actual W.P.C.	Actual Watts	Actual C.P.	Hours Life
10	.....	5.00	10	2.00	2,000
20	.....	4.15	20	4.80	2,000
25	Top.....	3.10	25.0	8.1	500
	Middle.....	3.31	24.1	7.3	725
	Bottom.....	3.52	23.2	6.6	1,050
30	Top.....	3.23	30.0	9.3	1,050
	Middle.....	3.46	28.9	8.4	1,500
	Bottom.....	3.69	27.8	7.5	2,100
50	Top.....	2.97	50.0	16.8	700
	Middle.....	3.10	48.2	15.2	1,000
	Bottom.....	3.39	46.4	13.7	1,500
60	Top.....	2.97	60.1	20.2	700
	Middle.....	3.18	57.9	18.3	1,000
	Bottom.....	3.39	55.7	16.4	1,500
100	Top.....	2.97	100.0	33.6	600
	Middle.....	3.18	96.4	30.5	850
	Bottom.....	3.39	92.9	27.4	1,350
120	Top.....	2.97	120.0	40.4	600
	Middle.....	3.18	115.8	36.6	850
	Bottom.....	3.39	111.4	32.8	1,350

of a 60-watt lamp would greatly improve the quality and quantity of light delivered, and would warrant the slight increase in cost of operation to the consumer. For a period of 1500 hours the use of the 60-watt (top voltage) lamp (consuming 4 watts more per lamp) would pay its extra renewal cost to the central station over the old-style 16-cp, 3.5-watt lamp, which is now rated as the 60-watt (bottom voltage) on sale of energy as low as 4½ cents per kw-hour.

Higher efficiency lamps are the solution of a lot of problems. They improve the light on the end of the circuits, when, during the peak load, the lamps ordered at bottom or even middle voltage are actually operating at lower efficiencies. They reduce the copper loss and raise the voltage on the entire circuit; also, figuring that the relative effect of voltage regulation is the same on, say, for example, the 50-watt lamp at either top or bottom voltage, a lamp of higher efficiency serves to steady fluctuations. By the new watt ratings the 50-watt lamp at top voltage corresponds to the 16-cp, 3.1-watt lamp and the 60-watt lamp at the middle voltage to what was the 16-cp, 3.5-watt lamp.

Finally, it is recommended in supplying the modern call that for beter light the 60-watt, top voltage, lamp should be used. Of course, if rates are adjusted to a higher economy lamp, the mazda lamp could be used, for with it the central station would be getting financially the most efficient lighting service possible from its plant. The accompanying table shows the relations between volts, candle-power, watts and life of the carbon 100-130-volt lamp.

In the future all regular carbon lamps made by the member companies of the National Electric Lamp Association will be designated by wattage and given the three-voltage marking, the arrangement being similar to that used with tungsten, tantalum and graphitized-carbon filament lamps.

EARLY TELEPHONE APPARATUS AS IT APPEARS TO-DAY.

By E. A. Hawkins.

The telephone industry dates back to the year 1876, at which time the first commercial telephone was placed in service. The beginning of a new industry is always marked by a quick succession of more efficient types of apparatus. This is particularly true of the telephone business, which has experienced many epoch-making changes, such as the introduction of the multiple switchboard, of the lamp signals, and of the central battery exchange equipments. The remarkable contrast between the oldest and the latest types of switchboard will be seen by reference to Fig. 1, which shows a magneto switch-

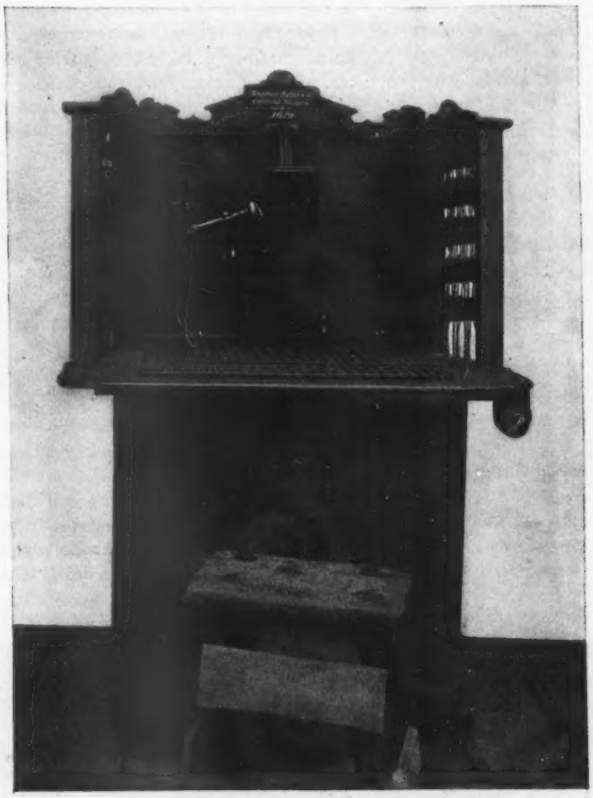


Fig. 1—A Gilliland Switchboard of 1879.

Fig. 2—Modern Telephone Equipment.

board built in 1879, and to Fig. 2, which illustrates a central-battery, multiple switchboard built in 1909 and recently installed at Cedar Rapids, Ia. On account of the fact that the telephone art has passed through a long series of important developments it is all the more remarkable to note the similarity between many of the earlier types of apparatus and the corresponding types of to-day.

A striking example of this fact is the telephone receiver. By referring to Fig. 1 a similarity will be noted between the telephone receiver there shown and the telephone receiver of to-day. Although telephone engineers of all countries have been endeavoring to increase the efficiency of the present receiver, the receiver of long ago would compare very favorably with that of to-day.

Another example of the similarity of the old designs to the

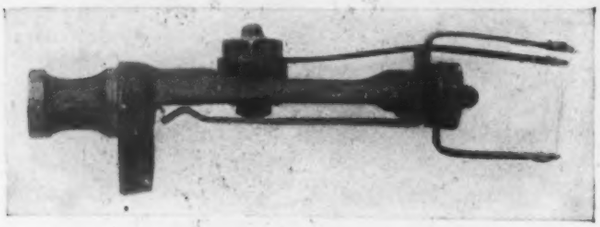


Fig. 3—Old Time Jack.

present equipments is the case of the Liverpool jack shown in Fig. 3. This type of jack was first built in 1883, 27 years ago, and yet this same jack is being manufactured to-day for use on private-line and toll-test panels, where very exact service is required. The fact that many of the old designs have stood the test of time speaks well for these designs and for the pioneer work in the manufacture of telephone apparatus. Not only was the old apparatus well designed, but it was well made, as is evidenced by the exceptionally long life of such apparatus.

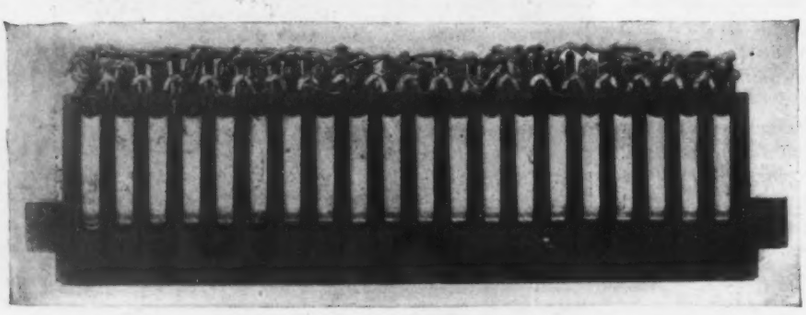


Fig. 6—Strip of Old Time Jacks.

Other examples of the long life of apparatus are as follows: Fig. 5 shows a strip of a type of drop which was made about the year 1880. The strip here shown has seen long service, as these drops were first used in magneto switchboards installed by the Merchants' Telephone & Telegraph Company, of Ottawa, Kan., and by the Missouri & Kansas Telephone Company at Marysville, Mo., at about 1880. These switchboards were the first type to be operated by switchboard cords. This same type of drop was later used with success on multiple switchboards.

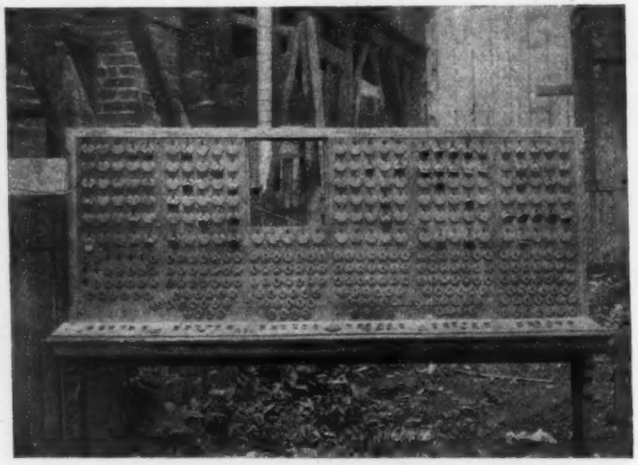


Fig. 4—An Old Key Type Switchboard.

The jacks shown in Fig. 3 have also been long in service. These actual jacks were taken from an old multiple magneto switchboard installed in Kansas City, Mo., in the summer of 1883. After serving in the Kansas City exchange 12 years, this board and its original equipment were transferred to Independence, Mo., where they remained in service until 1905, making the total life of the equipment 22 years.

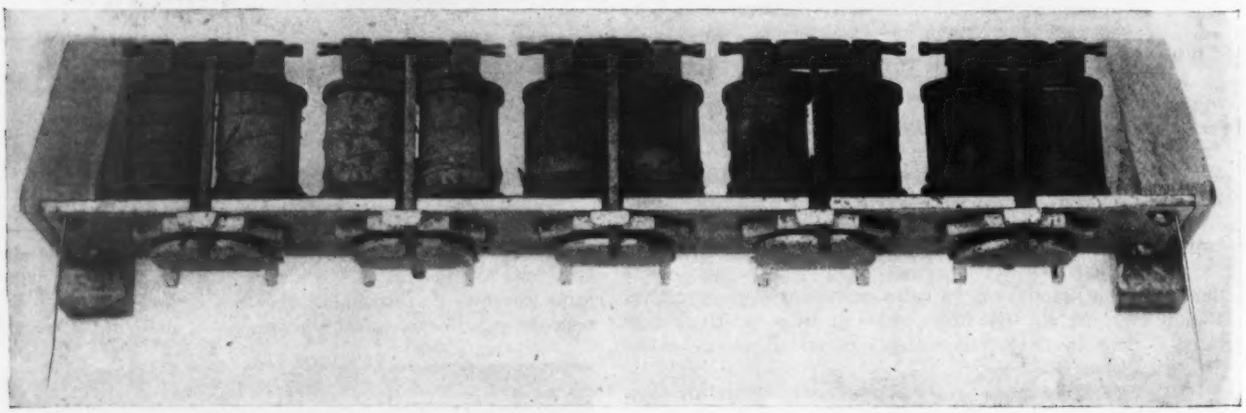


Fig. 5—Strip of Old Time Drops.

Fig. 6 shows a strip of jacks installed by the Cincinnati Suburban Bell Telephone Company in 1896. After being in service at Cincinnati for three years this equipment was replaced by a central-battery board and the old switchboard sold to the Missouri & Kansas Telephone Company, who installed it in the East Office Exchange. The board remained in service at this exchange until February, 1903, when it was transferred to Joplin and remained in service until February, 1909. This strip of jacks has been in service 13 years, which is very long life for multiple jacks built at that time.

The Western Electric Company, which from the very first has been closely identified with the development of telephones, is soon to establish a telephone museum at its New York plant to illustrate the development of apparatus and switchboards and to preserve some of the early models, which will be of increasing interest as the state of the art advances.

AN OZONIZER WITH A FAN ELECTRODE.

Ozone and the field offered by the possibility of its manufacture by means of electricity for small as well as large users are attracting the attention of central-station men in an increasing degree. One of the most recent of the equipments made for this purpose is that devised by the Standard Electro-Utilities Company, 312 Fifth Avenue, Chicago, which manufactures the "Vohr" electric ozonizer illustrated in Fig. 1. Fig. 2 shows the

Fig. 1—Ozonizer with a Fan Electrode.

apparatus employed, with the case removed and without the transformer, which is in practice placed beneath the apparatus shown.

One of the essential features of the device is the use of a small electrically driven fan as an electrode. This is the second, or inner fan, shown in Fig. 2, where the outer fan is simply a suction fan to help pull the air through the ozonizer and keep anyone from thrusting wires or other articles into the "live" parts. The inner fan is of a peculiar pattern and itself constitutes one electrode of the apparatus for producing the brush discharge. Surrounding it is a ring of glass 6 in. in diameter and 2½ in. wide. On the outer surface of this ring, or annulus, is placed a metal band, which is the other electrode of the apparatus.

There is an air-gap between the fan-blade electrode and the glass annulus. The air is drawn in at the other end of the case by the suction of the fans and as it passes through the violet glow of the brush discharge, a portion of the oxygen is converted into ozone and discharged through the screened opening shown in Fig. 1. The product is ozonized air rather than ozone, the content of ozone being simply large enough to give

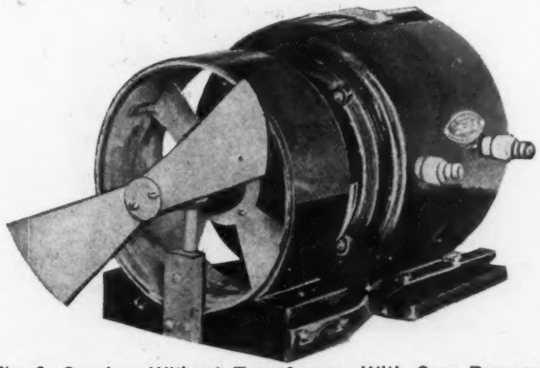


Fig. 2—Ozonizer Without Transformer, With Case Removed.

the briskness or freshness desired—the "mountain-air" effect—for close and stuffy rooms. However, means are provided by which the proportion of ozone in the ozonized air may be increased if desired.

These machines may be connected either with 110-volt or 220-volt circuits, and operated on either direct current or alternating current (60 cycle). If only direct current is available, a specially designed rotary converter is substituted for the alternating-current motor used in the case of an alternating-current source of electricity. The amount of electricity consumed is said to be about the same as that taken by one carbon-filament, 16-cp lamp. The device is simple, not apt to get out of order, and requires no cleaning.

One advantage claimed for the Vohr ozonizer is that its construction is based on careful study of the proper strength or quality of ozone in ozonized air for breathing purposes. Instead of delivering ozonized air at a greater concentration than is comfortable for some users, and then trusting to the various air currents in the room to diffuse and dilate it to the proper quality for respiration, the machine discharges ozonized air at a constant and uniform strength, and at the concentration approved, as it is said, by Ehrlwein and the leading European authorities.

Another feature to which the manufacturer directs attention is the fact that the period of ozonization is very slight, owing to the practically instantaneous passage of air between the electrodes. It is declared that the longer ozone, when generated, is allowed to remain in the field of the high-potential discharge, the greater is the possibility that the ozone will be changed back to the oxygen from which it was made, due partially to being subjected to great heat for an appreciable period of time. Furthermore, it is asserted that a long or continuous ozonization is apt to produce some nitrogenous compounds which are deleterious to health and are to be avoided. The Vohr machine dispenses the ozone almost at the infinitesimal instant of time at which it is generated. The transformer used with this apparatus is said to be specially constructed for the purpose, containing 9,000 ft. of wire.

Ozone has many industrial possibilities, as well as being useful in small quantities in freshening the air in dwelling houses, offices and factories. Its field embraces water purifying and many industrial enterprises, such as in breweries, tanneries, soap factories, laundries, the preserving of fruits and produce, the cyanide process in mining, the ageing of whiskey, and a number of others. The subject is one of present-day interest to electrical men, owing to the fact that the increasing use of this product will make necessary a corresponding increase in the use of electricity.

NICO INSULATING PAINT.

The National Insulator Company, 39 Sudbury Street, Boston, has placed on the market an insulating material in the form of a paint, which is stated to be unique with respect to its components. It is a non-metallic paint, brownish black in color, and is put up in 1-gal. cans, ready for immediate use without further mixing. The consistency of the paint is such that it may be applied easily to any surface, smooth or rough, wet or dry, and 1 gal., it is stated, will cover nearly twice the area of any ordinary paint. Its unusual property of adhering permanently to wet surfaces causes the paint to be especially applicable for use in underground conduits, manholes and basements. When applied to concrete it not only insulates the surface, but waterproofs it against considerable hydrostatic heads. Where applied to roofs for its waterproofing qualities alone, it is not eroded by running water. It is electrically punctured only by high voltages and its dielectric resistance is stated to be equal to that of glass. The paint is claimed to be unaffected by the strongest acids or alkalies, and to remain undisturbed on wood, iron, brick and concrete which are washed by salt water and exposed to the sun and weather.

Mechanically the paint is stated to remain flexible under extreme vibration without showing signs of cracking or blistering, and when applied to hot surfaces, such as fire doors or boiler flues, withstands very high temperatures without losing its protective qualities against rust and corrosion. The paint, it is stated, does not contain any linseed oil, will not pulverize upon oxidation, as linseed oil paints tend to do, and, being from acids in itself, does not cause local corrosion when applied to copper or any other metal.

CLAMP INSULATORS.

A novel type of insulator which altogether avoids the use of a tie-wire, which can be installed quickly and permanently, is the invention of a practical line-construction man in St. Louis. The varied troubles resulting from the use of the tire-wire are all too well known to those having the maintenance of overhead lines in charge. The breaking of spans due to corrosion at

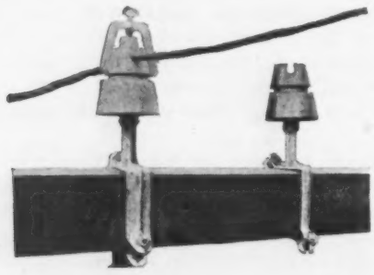


Fig. 1—Clamp Insulator.

the tie-wire and to kinks caused by the linemen tieing the wires are probably the most frequent of these difficulties. Sometimes the swinging of the spans will loosen the tie-wires, causing the lines to drop down on the cross-arms. One of the most difficult troubles to locate is a break due to corrosion at the tie-wire, in which the conductor separates but is held in place by the twisted neck of the tie. The insulator offered to replace the present tied type of construction comprises, as shown in Fig. 1, a porcelain stool and petticoat of the usual form for pin mounting, but having cast across its top a deep slot for the wire or cable. This slot is nearly rectangular in cross-section, with its bottom sloping toward the center from each edge. At the center the slot widens to accommodate a round porcelain pin which clamps on the wire and is held firmly by a galvanized-iron bale and thumb screw, not dissimilar to those used on some fruit jars. The combination of the sloping slot and the pressure pin exerts a powerful grip on the wire, which is said to be sufficient to allow the line to be thus dead-ended by clamping without other hold. As the wire is carried at the very top of the insulator, the length of leakage path for the same over-all height of insulator is very much increased over that of the standard pattern, in which the charged line and tie-wires are not so far isolated from the pin. The reduced amount of material which is in this way required for the same voltage insulator is thus responsible, it is explained, for the lower cost of the clamp type described. The bale itself may be used over again, and in the case of serious rusting or destruction by oxidization of the screw, the latter

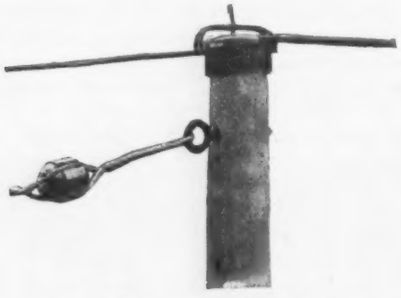


Fig. 2—Clamp Pole-Top Insulator.

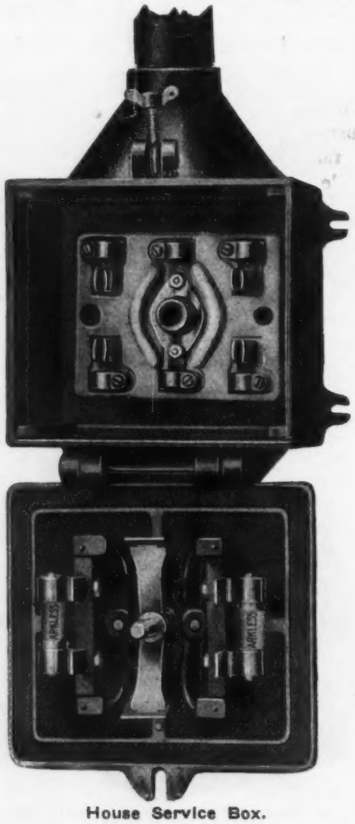
can be replaced at a trifling cost, or, in fact, at an expense less than that for a tie-wire.

A modification of the same principle is shown in Fig. 2, which illustrates a pole-top insulator designed to accommodate a single wire or trolley feeder, which is clamped into place as before. The insulator is so constructed as to be easily cemented over the top of the iron pole. The inventor of these devices, which many other experienced line-construction men have characterized as filling an important need in putting up wires of all kinds, is Mr. John L. Fay, general foreman of overhead-line construction of the Union Electric Light & Power Company, St. Louis, Mo.

HOUSE SERVICE BOXES.

A line of service boxes embodying many new features is being placed on the market by the Detroit Fuse & Manufacturing Company, Detroit, Mich., under the name of the "Detroit" service box. In addition to being water-tight and rust-proof, the box unites the functions of a quick make-and-break fusible switch. The manufacturers call particular attention to the fact that the switch mechanism is operated from the outside of the box, and that it can be controlled instantly and without danger of accidental short-circuit. This feature is of particular value when installations are made in manholes or in damp basements, for which service this line is especially recommended. Moreover, in replacing blown fuses, contact with any live parts is prevented. The switch mechanism is simple, and is controlled by one spring of sufficient strength to throw the switch either on or off independently of other pressure.

The box is threaded at both ends for conduit, and is provided with enlarged top and bottom spaces, which do away with bending of wires and allow plenty of room in wiring. The box can be sealed to prevent tampering, yet the switch mechanism can be instantly controlled from the exterior by the handle, shown in the cut. Hinges, plunger rods, and wing nuts are of brass, preventing rusting, and the cover is provided with a gasket, giving a water-tight construction.



House Service Box.

It will be noted in the illustration that the ouside legs are fused for National Electric Code cartridge fuses, while the neutral leg is connected directly across the terminals—a new feature in service boxes. The terminals are of the soldered lug type, and sufficiently large to take No. 2 wire. It is impossible to make or break the circuit by opening or closing the cover, so that the switch must always be operated by means of the quick make-and-break mechanism.

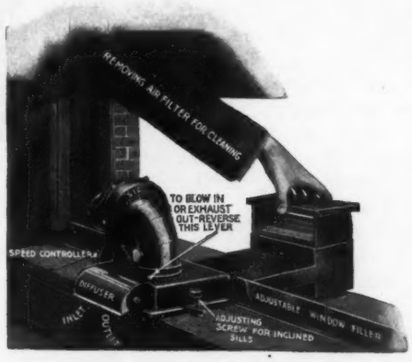
MAGNETO LOCK SWITCH.

The Connecticut Telephone & Electric Company, of Meriden, Conn., has brought out a new type of automobile magneto switch which is fitted with a "Yale" lock so that when desired it is impossible to operate the ignition systems. This switch also cannot be operated when the plug is removed, thereby practically making a double lock. It will be seen from the illustration that the lock is placed in such a position that it does not disfigure the switch in any way. It should afford a great deal of satisfaction to the owner of a car that he can leave it anywhere, and that by means of some such device his car cannot be used when left in the garage. The device furnishes a means of locking the controlling switch of a double ignition system.

Magneto Lock Switch.

FAN SYSTEM OF VENTILATION.

The "Sirocco" electric fan and air purifier is a device developed by the American Blower Company, Detroit, Mich., and Troy, N. Y., using a "Sirocco" standard turbine-type impeller wheel 3 in. in diameter as the basis for bringing the fan system of ventilation within the reach of everyone using electric energy. The small space occupied and the light weight combine to make the "Sirocco" device portable and attractive. On account of the efficiency of the "Sirocco" fan, the electric motor is small (one-seventieth of a horse-power) and the electric energy requirement is almost insignificant. The complete outfit can be installed upon the window sill without tools. The fan, it is said, will supply 5000 cu. ft. of air every hour, diffusing same throughout the room or in any direction at will or deflected through radiator for winter ventilation. By the simple reversal of a small lever, without changing the position of the outfit or stopping same, the fan will exhaust from the room the dead air in the same large volume; for instance, when baking or ironing in the kitchen it is desirable to exhaust hot air from the kitchen and thus prevent the heat from being driven into adjacent rooms. The complete outfit consists in addition to the "Sirocco" fan, motor and reversing mechanism, an adjustable outlet nozzle for summer use, speed controller, a dozen filter cloths and window-sash lock which prevents the window being raised from the exterior after the outfit is in place, and a rustless steel window filler adjustable to standard width sashes.

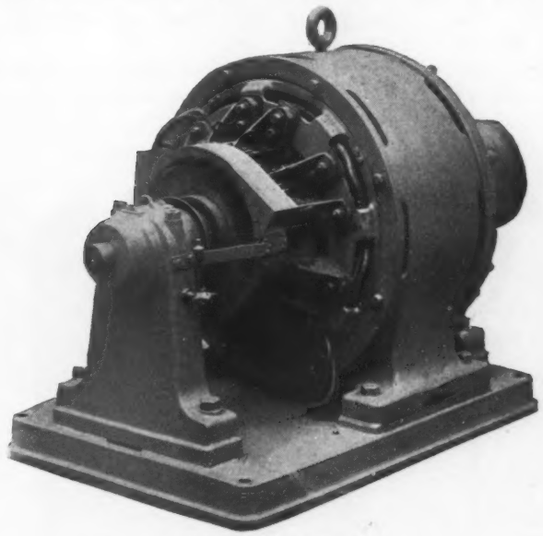


Electric Ventilating Fan.

PHASE ADVANCER FOR INDUCTION MOTORS.

The phase advancer recently developed by Mr. Miles Walker is intended to strengthen the position in the industrial field now occupied by the induction motor. This device is in reality an exciter, which supplies exciting current to the secondary of an induction machine. The electromagnetic relations in the phase advancer, considered in conjunction with the induction machine, have been set forth at length in previous issues of this paper.

The use of a phase advancer in the secondary of an induction motor permits the adjustment of the power-factor through unity to leading, thus making it possible to use one induction machine so equipped to compensate for the lagging currents taken by other induction machines operating on the same lines. The adjustment of the excitation also allows of some regulation of the motor slip, which is of value in starting and to a certain extent in speed adjustment, by doing away with rheostats in the motor circuits. It is claimed that a 750-hp, 50-cycle, three-phase induction motor requiring 175 kva magnetizing current can be operated at unity power-factor with a 6-kva phase advancer and with a 12-kva phase advancer it can be operated at 0.7 leading power-factor. This leading current is sufficient to supply the total magnetizing current to 600 kw of outside motors on the same lines.



Phase Advancer.

Furthermore, by adding copper to the induction motor and using the 12-kva phase advancer, the line will feed three motors of the same size aggregating 3000 hp at unity power-factor. Assuming such an aggregate to have a power-factor of 0.92 without the phase advancer and a line loss of 10 per cent, a saving of 40 kw will be attained. When comparing with less efficient motors of lower power-factor the gain is correspondingly greater.

The use of phase advancers for supplying magnetizing current to induction generators also bids fair to greatly facilitate the introduction of this type of machine. The induction machine

under ordinary conditions must draw all its excitation current from the network to which it is connected and, therefore, in cases where the synchronous generators in parallel with it have to supply this magnetizing current, the regulation with low power-factor load is very difficult. When phase advancers are used not only does the induction machine require no magnetizing current from the other machines, but it actually assumes its share of the lagging component of the load current. The ease with which induction generators may be started and synchronized, and especially in the case of gas-engine driven and other slow-speed units, would seem to indicate that induction generators will come into increasing use.

The illustration shown herewith is a view of a phase advancer made by the British Westinghouse Electric & Manufacturing Company, Limited, who manufacture the machine covered by Mr. Walker's patents.

PRINTING ATTACHMENT FOR WATT-HOUR METERS.

Much general interest has been manifested in the method of selling electrical energy to street-railway and large industrial energy consumers which has been developed in Chicago. The Chicago Central-Station Company has had remarkable success in securing energy contracts of unusual size, and it is believed that the largest contracts for electric energy ever made anywhere are held by this company.

The method adopted has thus far been applied principally to the sale of electricity for street-railway purposes, but in several cases it has been and is being applied to the sale of

Fig. 1—Printing Attachment for Watt-Hour Meter.

industrial energy. It consists, first, of an annual demand or primary charge which covers all fixed charges on the investment in the portion of the central-station system which is actually used by the particular customer. This primary charge is based on the greatest one-hour demand in the year. In addition to this demand charge, there is an output or secondary charge at a fixed rate per kw-hour to cover fuel, labor and other operating expenses, and this charge is based on the total registration at the end of each month.

The correctness of methods of charging based on actual cost of production has already been accepted by several public and municipal bodies and commissions. The "Chicago method," as it is called, applied to street-railway energy measurement during the last seven years, has been developed and is applied now to the sale of electrical energy amounting to a maximum demand of over 80,000 kw.

It is interesting to note how the electrical energy is metered to these large customers. At first the watt-hour meters were read by the operators at the end of each hour. Then various graphic and other instruments were tried, but because of the extreme accuracy required in the determination of the maximum demand for such large qualities of electricity, the use of watt-hour meters was continued. Efforts were then made to read these watt-hour meters automatically, which finally resulted in the perfection of the Chicago printing attachment for the watt-hour meter, the general appearance of which is shown in Fig. 1.

This attachment can be applied to any high-grade direct-current or alternating-current single-phase or polyphase watt-hour meter, and it prints in ordinary figures on a 1½-in. strip of paper the actual registration in kw-hours at the end of every five-minute interval, or longer interval, as may be desired. Fig. 1 shows the Chicago printing attachment for watt-hour meters, while Fig. 2 is a photograph of a 24-hour record of total kw-hour registration as shown by the use of this device. The printed record is removed and a new roll of paper inserted at the end of each day or week.

The printed registration slip shows the actual consumption during every five minutes or longer interval, from which may be ascertained immediately the particular hour of the day and day of the week when the maximum demand occurred. This maximum is not momentary, but is the average for the five-minute or longer period desired, as registered by the watt-hour meter.

Fig. 2—24-Hour Record of Total KW-Hour Registration.

This attachment has been developed by men who have had many years' experience in large electric motor work, and the problems of sale and metering in connection therewith. It is especially advantageous in the sale of electric energy to large consumers. By means of the continuous record, the central-station company is enabled to know exactly all the vital conditions, and hence the cost of the energy which it supplied to a particular customer.

Originally this printing attachment was developed and put on the market by the Chicago Electric Meter Company. This company was later absorbed by the Minerailac Electric Company of Chicago. The latter company has worked steadily and cautiously to perfect the device. Several types applicable to the various requirements of metering are now available.

Type A was the first and simplest form, printing at intervals of one hour only. Type B has the added feature of being adjustable to print at different intervals, as 5, 10, 15, 30 and 60 minutes. It also has automatic movement of the inking ribbon. Type C, which is the one shown in Fig. 1, is a radical departure, in that it is not contained in the meter-case, but is separately mounted either on the front or rear of the switchboard, or on a separate panel. It is electrically connected to the meter, thus leaving the meter-case unchanged and its original register dial intact. This type may be installed by the customer without sending his meters to the factory, thus making it possible to apply the printing attachment to large series meters on switchboards where it is impracticable to remove the meter from the board. Mounted in a case, complete with clock relay, this type of attachment is readily adapted to meters on customers' premises, either for permanent installation or temporary testing purposes, and it may be changed from one meter to another. It will be exhibited at the coming N. E. L. A. convention in St. Louis.

MILEAGE RECORD BY ELECTRIC TRUCK.

A 4000-lb. electric truck, built for the Amoskeag Manufacturing Company, by the General Vehicle Company, was run from Boston to Manchester, N. H., last week on a single charge, the distance being 59 miles. The truck was shipped to Manchester by Day Baker, manager of the Boston office of the General Vehicle Company, and throughout the trip a load of 2500 lb. was carried. The route included the cities of Lowell and Nashua, a stop being made at the Lowell Textile School to enable the students to examine the equipment. The truck made an average speed of 8.57 miles per hour on the trip. Between Boston and Nashua the roads were in good condition, but on the last leg of the journey, 19 miles, hilly and sandy highways were encountered. No boosting of the battery was done en route. The truck is the seventh machine of its kind to be purchased by the Amoskeag Company, which is understood to be securing decided economies with electricity compared with the horse traction formerly used in its yards. The trucks are used mainly for inter-mill service and a feature of the work is the constant overcoming of heavy grades. Particulars of the Amoskeag company's garage and service have been published in this journal in connection with the meetings of the Electric Vehicle & Central-Station Association.

FAN OSCILLATOR.

The Sprague Electric Company has developed an oscillating device for use on the line of Lundell fans, shown in the accompanying illustration, which may also be supplied to a non-

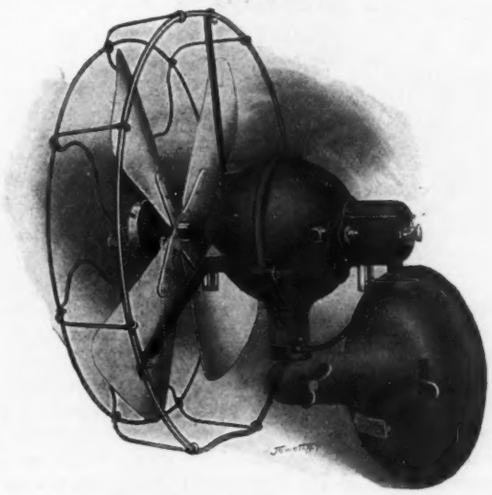


Fig. 1—Oscillating Mechanism Attached to a Lundell Fan.

oscillatory fan. The oscillator mechanism is very simple, and can be attached to the 1910 type of Lundell non-oscillating fan

Fig. 2—Oscillator Mechanism.

by anyone in an incredibly short time. The change from one type to the other has been made in 60 seconds. The accompanying illustrations show the oscillator mechanism and the Lundell fans with and without it.

NON-BLACKENING TUNGSTEN LAMP.

It appears that in the filaments of many tungsten lamps there are slight traces of carbon, which not only render the filament more or less unduly brittle, but also detract in time from the efficiency of the lamp owing to the blackening of the bulb due to this cause. The presence of the carbon is attributed to the hydrocarbons employed in the binder in making the filament. In the sintering operation these carbonize and although an effort is made to eliminate the carbon by subjecting the filament to a heavy current of electricity in an atmosphere of hydrogen so as to burn off any remaining portion of the binding material and complete the reduction of the tungstic oxide, traces still remain. Recognizing this serious defect, the American "Z" Electric Lamp Company, of New York City, has sought to nullify the presence of the carbon by introducing a substance into the lamp bulb itself or incorporating it in the filament, with which the carbon will react and form a compound not detrimental to the life of the lamp nor to its efficiency as a source of light. The substance, phospham, a

Non-Blackening Tungsten Lamp.

phosphorus-nitrogen-hydrogen compound, has been found to be especially suitable for this purpose. It is claimed that not only is the nitrogen in the compound released in vacuo at a comparatively low temperature and when set free forms with carbon, cyanogen or cyanogen compounds, but likewise the phosphorus which is set free at the same time combines with the oxygen still present further to reduce the tungstic oxide. The remarkable feature of the lamp thus treated is that the carbon still remaining in the filament is rendered harmless so far as blackening of the bulb is concerned. In the lamp illustrated herewith the phospham is applied as a coating on the glass rod which supports the filament and can be distinguished in the engraving. Another feature which the lamp possesses is the method of supporting the filament. At the top of the lamp globules of pure tungsten are employed to fasten the filament, which is electrically welded to the supports. The springs shown at the tip end of the lamp, through which the filament threads, serve to hold the filament under a slight tension, enabling the lamp to be burned in any position. The lamps are made in 18-watt sizes for potentials up to 130 volts and in from 25-watt to 250-watt sizes for circuits having potentials ranging as high as 250 volts. The life of the lamp is claimed to be 1000 hours and the specific consumption 1.25 watt per candle.

AN INTERESTING ELECTRICAL SIGN.

The electrical sign, of which the accompanying illustration can only convey an incomplete idea, was erected in Chicago by the Thomas Cusack Companies for a corset manufacturer and more recently removed to St. Louis. The name is stationary, and at intervals the border is flashed, after which the

Electrical Sign.

flowers (morning glories) and leaves seem to open up gradually until full bloom is simulated. This is accomplished by means of colored electric bulbs placed at the rim of each flower. The various connections of the lamps are produced by a "Flasher" specially constructed for this sign by the Reynolds Electric Flasher Manufacturing Company, of Chicago, Ill.

ELECTRIC RANGE.

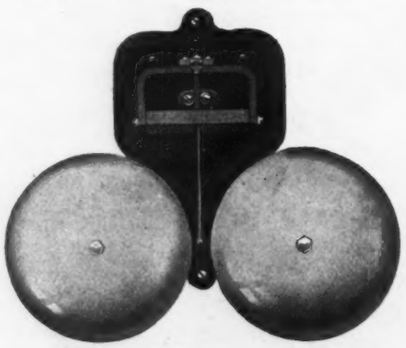
The Diamond Electric Company, Binghamton, N. Y., manufactures the "Delco" electric range, which is a compact, attractive and convenient combination of devices necessary for general cooking. An enameled wrought-iron frame surrounds an oven and supports a top of fire-and-moisture-proof ebony asbestos plate, upon which are attached the hot plates and other heaters. The range occupies a floor space of 20 in. by 30 in., weighs 75 lb., and is built for service connection. The oven, which is 11½ in. by 14½ in. by 19 in., has a let-down, grate-protected, glass door, which permits of inspection of the cooking without the loss occasioned by heating the cold air

Electric Range.

admitted when the door is opened; the grating, when the door is opened, supporting the weight of the utensils above the glass. The range possesses air-wall insulation, double at top and bottom, and having no castings to absorb heat; a material saving in energy consumption is claimed. In order to eliminate the natural congestion of superheated air at the top of the oven, a downward reflecting plate is placed above the upper heating element. Between the oven and the top of the range is a chamber for wiring, enclosed by panels, supporting switches, pilot lamps, service connection block, etc., the rear panel being easily removed for inspection. This chamber protects all wiring from abuse and collection of dust, etc. The top is furnished with any desired selection of devices, each being operated by a single or three-heat switch having a pilot lamp in circuit. The standard range has one 8-in. and two 6-in. disk heaters, one horizontal radiant toaster, one griddle and one broiler, interchangeable on porcelain locaters. A wall attachment plug base is located upon one panel, into which may be connected any device exterior to the range, such as, for instance, a flatiron, the latter then having a pilot-lamp and switch connection. The range is wired for a two-wire and three-wire system, and a flue-connection canopy is furnished when desired. The entire outfit is attractive, convenient and economical, the total power consumption being given as approximately 5 kw.

MINE SIGNALING SETS.

The ironclad equipments described herewith are the product of the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., and are intended to meet the requirements for general alarm-signal systems as operated in mines. The loud-ringing signal bell is a polarized ringer operated by an alternating-current magneto generator. The frame and housing for the armature and clapper-rod mechanism are of cast metal finished with a special enamel which is rustproof, and either 6-in. or 8-in. gongs can be used. By referring to the open-view



Loud-Ringing Bell for Mines.

illustration it will be seen that the armature mechanism is free from complicated adjustments, and that the magnetic coils are protected from moisture by being encased in metal cases that are hermetically sealed. The terminal wires to the ringer spools are fastened outside of the metal case. The adjustment for the armature is furnished by the two upright posts on either side of the armature piece. These posts have a tapered end which is located eccentrically on the end of the post that fits in the tapered hole in the base. By turning these posts to or from the armature piece a wide range of air-gap is provided, and any adjustment required is instantly furnished. For a mine signaling system it may be desirable to put several of these polarized bells on the same line with the company's magneto generator. Ten of these bells on a bridging line can be successfully operated from one generator, and under favorable conditions as many as 20 may be rung satisfactorily. The ironclad magneto generator is a waterproof equipment that is simple, but practical for mine use. Detachable mounting bars are furnished. The cast-iron housing is made with a drip on the front over the door. Incoming wires are terminated in the terminal box mounted on the lower side of the casting. As will be seen by the open-view illustration, the generator is mounted on the shelf which forms a part of the front door, eliminating the features of mounting the generator on a separate plane, which makes it impossible to get an accurate alignment for the crankshaft. The crank handle passes through an air-tight gasket mounted on the door and engages a shaft coupling on the opposite side. By this method positive operation is assured and the generator can be started instantly.

WATERPROOF TELEPHONE FOR MINES.

In order to obtain an absolutely waterproof iron-clad magneto telephone that will resist climatic conditions and those prevalent in underground workings, the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., considered it best to have all the apparatus within a hermetically sealed inner

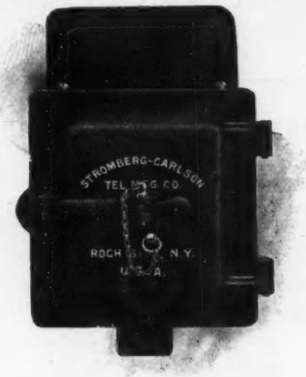


Fig. 1—Generator Closed.

compartment, allowing only the receiver and the crank for the magneto generator to be exposed. The receiver must necessarily be exposed in order that the user can hear the conversation from the party he has called or been signaled by. The receiver cord must be flexible and at the same time waterproof, and of

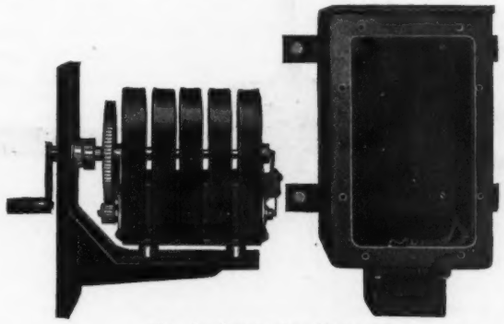


Fig. 2—Generator Open.

such length as to enable the user to conveniently stand before the instrument.

The latest design of cord for this purpose is of the switchboard type, having an extra insulation of pure rubber over which is braided a strong linen covering saturated in beeswax

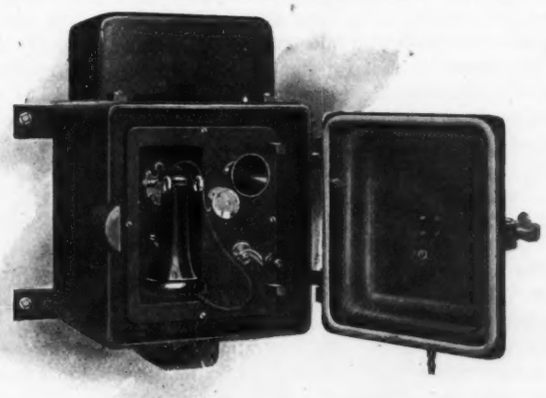


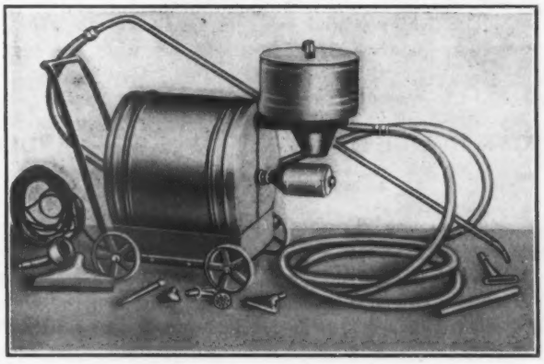
Fig. 3—Mine Telephone Open.

so as to fill up the apertures between the weavings to provide a cord that is waterproof, and at the same time one that will not collect mineral dust that in time will wear through the cord braiding that is not protected in this manner. A receiver cord take-up device is shown in the illustration, which automatically releases and winds up the cord so that it cannot lay over the edges of the box and be crushed and broken when closing the door hurriedly, as is often the case.

Another improvement which it is claimed insures an operative signaling generator at all times is the metal mounting for the generator in place of wood. Irrespective of what precautions are taken to protect the contents of a mine telephone, wood will shrink and expand and place the generator out of alignment, thereby making the crank shaft bind in the door and make it impossible to operate the generator or signal any other station in the system.

PORTABLE VACUUM CLEANER.

The Russell portable renovator, made by the Zimmer Vacuum Renovator Company, of Minneapolis, Minn., and illustrated herewith, possesses also a germicide attachment for deodorizing and fumigating the exhausted air. An electric motor drives a pump having four cylinders and operating at a speed of 175 r.p.m. It is claimed that from 65,000 to 85,000 cu. in. of air is handled per minute at a blowing pressure of from 6 lb. to 10 lb. This amount of air rushing into the nozzle applied to the article to be cleaned sucks the dust and dirt into the receptacle can, where the air and dust are separated, the dirt remaining and the air finding its way into the room through the deodorizer which is attached to the air exhaust. The machine



Portable Vacuum Cleaner.

as shown is equipped with four rubber-tired wheels, making it easily transportable and rendering it impossible to mar or damage hardwood floors over which it may be drawn. By reversing the hose connection, the air current is reversed, and passing through the germicide solution may be employed to freshen pillows, mattresses and many other articles. A stationary renovator, known as the "Morey," is also built on the same principle by the company. The latter machine, which has the same suction capacity as the portable device, is intended for installation in cellars whence pipe lines radiate to the floors where connections to the tool attachments are desired.

LARGE CAPACITY TIME SWITCH.

The Hartford Time Switch Company, Hartford, Conn., is placing on the market a line of time switches automatically controlling up to 300 amp in single, double or triple-pole, as well as high-potential currents up to 2500 volts. In these switches, it is claimed, the controlling mechanism is of such construction as to make failure in action impossible, either through derangement of the mechanism or through failure to wind. A standard knife switch of ample capacity is operated by a quick-break mechanism which is positive in its action regardless of the state of winding or tension of the controlling springs of the clock-work mechanism; the throwing mechanism is entirely separate from the timing mechanism so that though the clock may run down if forgotten, the switch cannot stop

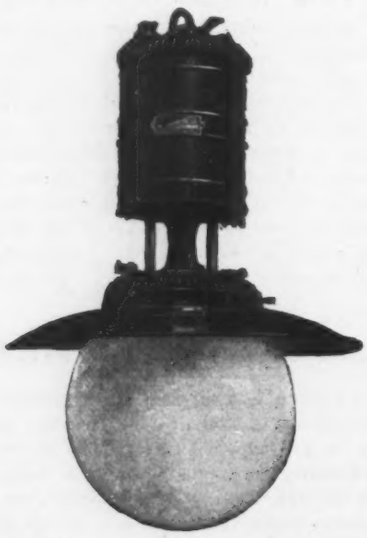
except at the extreme off or on point, and the quickness of break is in no way affected. The mechanism is in a waterproof iron case, the door locking with a subtreasury lock. The time mechanism used is a high-grade eight-day marine movement

Time Switch.

which has proved its qualities in many years of satisfactory service. The high-potential switches break in oil. The dimensions over-all are 19½ in. high, 9¾ in. wide and 7½ in. deep.

TUNGSTEN LIGHTING UNIT OF HIGH CANDLE-POWER.

The accompanying illustration shows a low-voltage tungsten lighting unit of high-candle-power brought out by the Warner Arc Lamp Company, of Wilton, Ia. In outward appearance the lamp resembles an arc lamp and it is regularly equipped with a tungsten lamp having a specific consumption of 250 watts. The upper portion of the lamp houses the necessary transformer and regulating apparatus to adapt the lamp to all lighting cir-



High Power Tungsten Lamp.

cuits. For straight series circuits, the lamp is designed to take any size of bulb from 32 cp to 200 cp with current ratings of 6.6 amp, 7.5 amp and 9.6 amp. For direct-current, multiple circuits a 6.6-amp, 250-watt, low-voltage tungsten lamp is furnished so that three lamps must be run in series on 110-volt circuits and six in series on 220-volt circuits. A 7.5-amp bulb is used on alternating-current, multiple circuits, together with a 250-watt transformer to reduce the line voltage to that required by the lamp. The mechanism of the lamp is guaranteed for a period of five years and besides the enclosing globe and tungsten lamp a fire-enamel shade is furnished. A life of 1500 burning hours is claimed for the tungsten lamp and where the lamps are connected in series circuits, automatic cut-outs are provided which insert the requisite resistance in the line when a lamp fails.

ALTERNATING-CURRENT CEILING FAN.

The accompanying illustration shows an alternating-current ceiling fan manufactured by the Hunter Electric Company, of New York City. A feature of its construction to which the manufacturer directs attention is the bearing. An ample oil chamber has been provided so as to allow for a sufficient flow of oil, the rotor bearing acting as a pump for raising the oil to

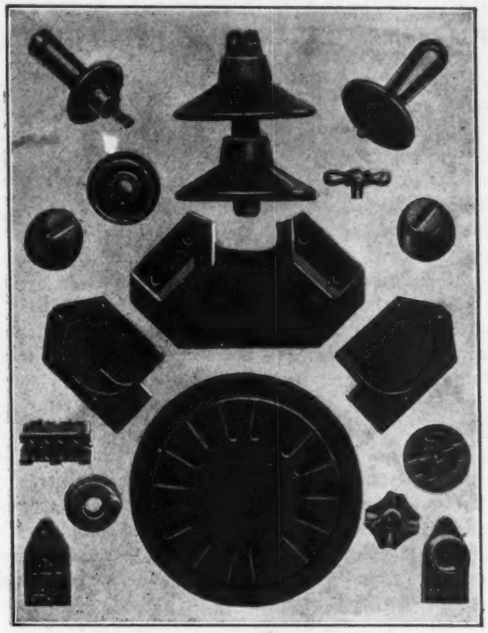
Alternating-Current Ceiling Fan.

the upper bearing, whence it returns through a gutter on the side to the lower bearing. The lower end of the rotor rests on a case-hardened disk which has its bearing on a series of balls which in turn bear on a similar disk. The bottom cap is arranged to avoid any chance of oil escaping and at the same time makes the bearing readily accessible for cleaning and adjustment. The fan blades are secured directly to the rotor. The motor parts, including the reactance coil used for speed regulation, are enclosed by an iron shield. The starting and regulating switch is embedded into the bottom of the frame. The type of fan shown is built for standard alternating-current voltages and for frequencies of from 25 cycles to 60 cycles. The suspension stem is adjustable and the case may be had in a number of different finishes.

MOLDED INSULATING COMPOUND

The Hemming Manufacturing Company, 2 Rector Street, New York, is introducing a fireproof insulating material called "Hemit." This composition is molded under pressure into the various forms shown in the illustration to meet the requirements of present practice. While it is not brittle, the substance is said to be quite hard and capable of taking a high finish. It is also said to possess great tensile strength and to be free from expansion and contraction so that metal parts can be fixed in place during the molding process. The manufacturer claims high insulating qualities for the product, which is also fireproof and waterproof. Among some of the more important uses to which the substance is applicable are the following: Switch

handles, switch bases, bushings, spools, controller parts, field-magnet spools, commutator rings, brush holders, solenoid housings, socket rings and keys, telephone receivers, arc shields,



Molded Articles of Insulating Compound.

sleeves, washers, trolley insulators, telegraph insulators, high-tension insulators, snap-switch parts, push-buttons and telephone mountings.

SIGN FLASHERS AND RECEPTACLES.

Flashers are sometimes called upon to make and break circuits carrying a very large load, as in the case of the main

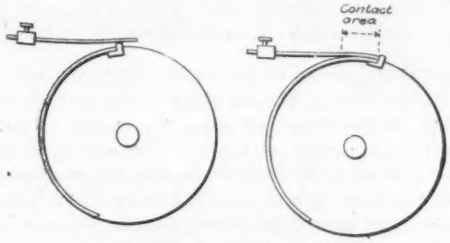


Fig. 1—Diagram of Commutator.

circuit on a large sign. There being no inductance in the sign circuit the make is accompanied by a rush of current

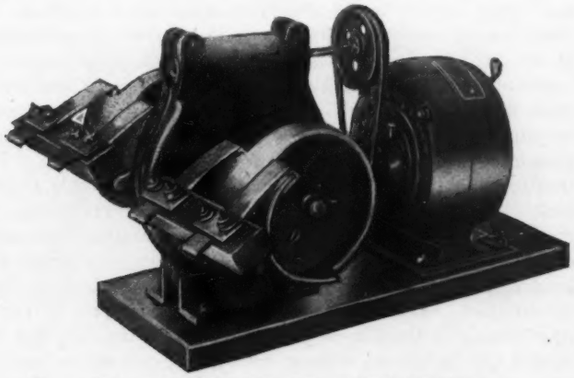
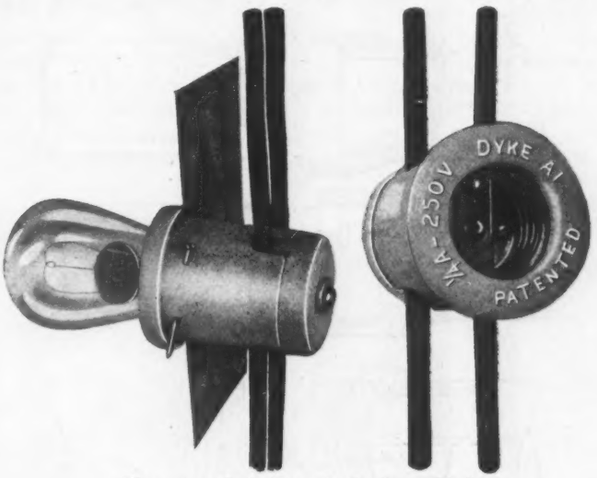


Fig. 2—Double Pole Two-Switch Flasher.

practically equal to the full load value. During the first instant the current must pass between the brush and the edge of the commutator, and increasing the size does little to protect the commutator edge and the brushes from damage. Due to this action the commutator becomes pitted and ragged on the edge, so that the lamps will flicker unsteadily instead of coming up with a flash to full brilliancy.

A device has recently been devised by Betts & Betts, New York, which furnishes a simple means of removing the limitation of the initial contact. By providing the leading edge of the commutator with an insulating block, suggestively called the "Noark Picup," as shown in Figs. 1 and 2, the brush is held completely away from contact until it comes to such a position that it will drop directly on the commutator, making the full and maximum contact area available at the first instant. It can readily be seen that this contact area can be so designed as to give the proper current density.

Another device which offers distinct advantages in sign construction is a special sign receptacle brought out by the same firm. This receptacle is called the Dyke; it is designed to reduce the work of wiring to a minimum. Figs. 3 and 4 show a receptacle assembled and Fig. 5 shows the parts. The receptacles are applied as follows: Holes are punched into the sheet-metal wall of the sign; the receptacle is then slipped through from the outside and two wire nails inserted in holes



Figs. 3 and 4—Receptacle Assembled.

provided in the porcelain base; the receptacle is now permanently in place. Next the back is removed with a screw driver, the wires dropped into the grooves and when the cover is replaced the receptacle is ready for the lamps. This does away with wire cutting, soldering, etc. This saves much time and makes a neat job of wiring. The contacts are knife edges and cut slits through the insulation as shown in Fig. 5. The cut is radial and does not greatly decrease the effectiveness of the insulation. It is claimed that the wire can be used over and over again. These receptacles, while of special value in temporary work which must be put up quickly and in which

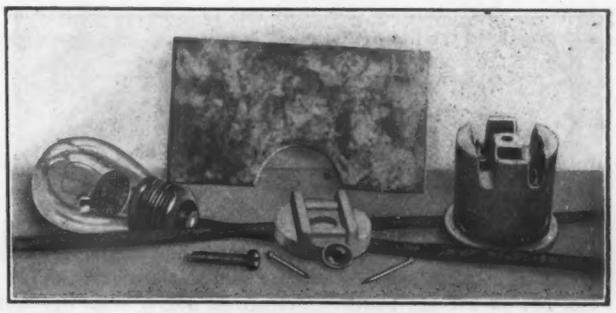


Fig. 5—Parts of Receptacle.

it is desirable to keep the scrap value as high as possible, are also claimed to be suited to permanent work.

INDURATED FIBER CONDUIT FOR UNDERGROUND WORK.

The H. W. Johns-Manville Company, of New York, manufactures an underground conduit of indurated fiber, which by reason of the absence of seams or roughness at joints makes it air-tight, thus preventing the seepage of concrete grout within the duct and rendering it possible, so it is claimed, to fish a No.

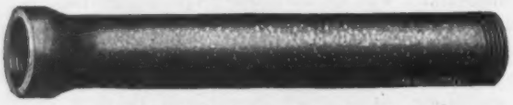


Fig. 1—Indurated Fiber Conduit.

6 wire from manhole to manhole, thus doing away with ropes and rods. Indurated fiber has been used quite extensively for insulating purposes, such as third-rail coverings, controller linings, battery boxes, etc., and in the process of manufacture into conduit, the fiber is molded into shape under pressure and high temperature so as to be without grain or lamination. This process results in a solid length of conduit with a ⅜-in. wall which is homogeneous throughout and which possesses a tensile strength that is remarkable when the weight of the finished duct is taken into consideration. An interesting feature of the

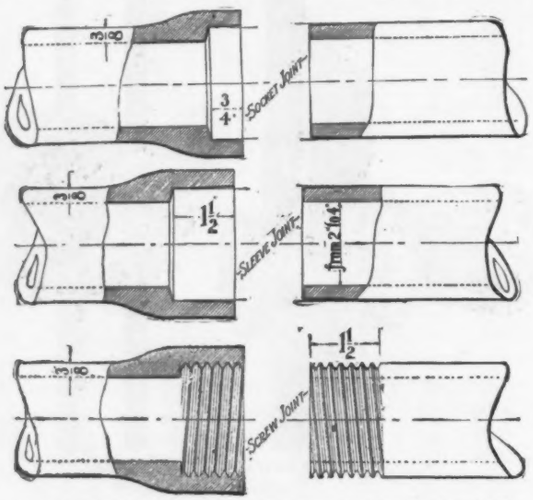


Fig. 2—Socket, Sleeve and Screw Joints in Conduit.

conduit are the bell joints. One end of each section is molded to an enlarged size with an opening as large as the outside diameter of the opposite end of the next section. Thus, any two sections fit together without any reduction in the wall thickness of either at the joint. Realizing, however, that installation methods of some systems have been devised which necessitate the use of straight joints, the manufacturer has also arranged the conduit with straight-line joints, as shown in Fig. 3. The joints being machine molded are smooth and true, and each length of duct is also smooth throughout its bore. The manufacturer claims that by reason of this fact the conduit should add greatly to the life of the cable, because seams or raw edges

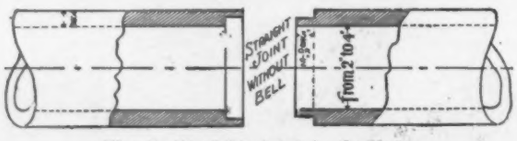


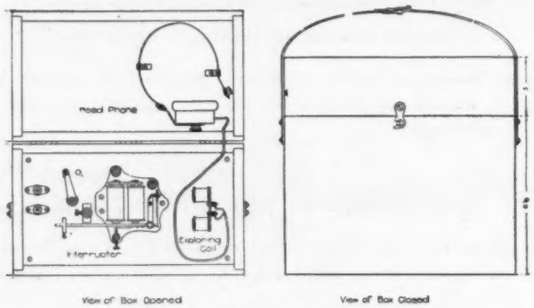
Fig. 3—Straight Joint in Conduit.

at joints, burrs, blisters, lumps, etc., are ordinarily the greatest causes of cable troubles. Tests are said to show that the conduit has an average puncture voltage of 40,000 when dry and 33,000 volts after 40 hours' immersion in water. The material has about one-sixth the weight of the ordinary clay duct, making it easier to handle and resulting in diminished freight charges. Breakage is low due to the high tensile strength of the fiber. A variety of bends, elbows, tees and other fittings are made for curves and irregularities in trenches; and two-way, three-way and four-way junction boxes provide for branch and service connections.

INSTRUMENT FOR LOCATING FAULTS IN CABLES.

W. N. Matthews & Brother, St. Louis, Mo., have brought out a simple, self-contained cable test set, designed for locating faults in telephone and telegraph cables. By means of the set low-resistance crosses grounds and shorts can be readily located. The set may also be used on wet cables, but unless the cable is very wet so that the resistance of the fault is low, difficulty will be experienced in locating this particular kind of trouble. The special field for the "Telafault," as it is called, is in the location of crosses, grounds and shorts, especially those due to lightning.

It often happens that lightning will enter a cable in spite of the fact that the boxes have the best of protection, travel several hundred feet and then arc from one pair to another, or from a pair to the sheath, causing a low resistance cross to ground. In many cases this trouble will be scattered through several pairs located along a considerable length of the cable. With the Wheatstone bridge and the ordinary Murray or Varley loop test this trouble can be located only approximately. The cable then has to be opened and tested both ways. Sometimes it is necessary to open the cable at several places before the faults are found. With the "Telafault" an interrupted current is placed on the line in trouble. An exploring coil is



Instrument for Locating Faults in Cables.

wired to the terminals of the head telephone receiver, which is worn by the tester. The exploring coil is then placed against the sheath of the cable and noise due to the induction from the interrupted current is heard. The coil is moved along the cable, and when the fault is reached, the noise will suddenly cease, the cable beyond the fault being quiet, while on the side of the fault toward the interrupter the noise will be heard. The exploring coil is so designed that by proper manipulation all return currents in the sheath of the cable tending to affect the positive and easy location of the fault are neutralized. This feature is covered by patents. In ordinary exploring coils the return current in the sheath in many cases causes an inductive noise, which results in a false location, or no location at all. When such coils are used the cable man sometimes overcomes this difficulty by removing the grounds and bonds from the cable. In many instances where the cables are small, 50-pair and under in size, it is possible to remove shorts and grounds due to lightning without opening the cable. The trouble is located by means of the coil and the cable is bent back and forth at the location of the trouble several times. If the trouble is in the nature of a small weld between two wires or one wire and the sheath due to lightning discharge, this bending movement will break the weld and permanently clear the trouble. Aside from the saving in labor there is also a large saving in the life of the cables due to the fact that the trouble can be located without cutting in extra splices, or cutting out long lengths of supposedly defective cable. With the old methods of testing where lightning trouble is frequent it is not uncommon to see four or five splices within as many spans, where the cable has been opened for the sake of testing and locating the trouble.

VACUUM LIGHTNING ARRESTER.

The Siemens & Halske Company has recently perfected a type of vacuum lightning arrester which it first introduced about 20 years ago for use on telephone and telegraph circuits. The early types had both terminals at one end and the difficulty involved in maintaining insulation under all conditions prevented the extensive use of this arrester in practice.

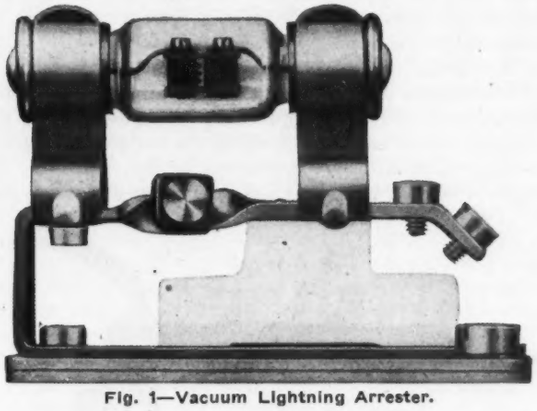


Fig. 1—Vacuum Lightning Arrester.

Special attention has therefore been paid to this point in connection with the present lightning arrester, which is represented in Fig. 1. The remarkable sensitiveness of this apparatus is due to the fact that the carbon plates are arranged with their fluted surfaces facing one another in a glass tube in which a vacuum has been established. The distance of the two carbon plates (line and earth plates) can accordingly be chosen sufficiently large to exclude any trouble due to short-circuits; furthermore, the transition is perfectly protected by the air-tight enclosure against the entrance of any dust or moisture. Nor can an accumulation of dust or moisture on the surface of the lightning arrester (which has been given the shape of a cartridge) give rise to any earth connections. Even after violent discharges, and which in some cases may burst the glass, a sufficient insulation has been found to exist against the earth.

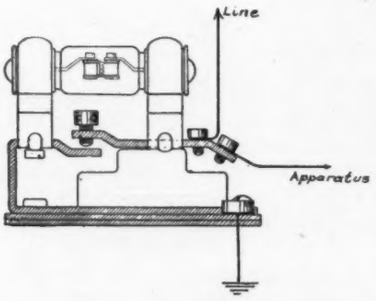


Fig. 2—Arrester Connections.

Fig. 3—Bank of Arresters.

The vacuum lightning arrester, as above mentioned, is designed as a cartridge readily fitted into a socket (Fig. 2), to which the line, the apparatus and the ground can be connected by means of set screws. The socket itself comprises a gap lightning arrester which, being connected up in parallel to the cartridge, will serve as reserve when the vacuum apparatus has been removed or destroyed or else in the case of especially heavy discharges when it assists in relieving the line of the excess energy, thus greatly increasing the safety of the arrangement. Any number of vacuum lightning arresters may be mounted with their sockets on a common metal base or earth plate. Fig. 3 represents a lightning arrester for seven lines used as substitute for the ordinary plate apparatus in connection with transmission line frame. In the case of double telephone conduits a double lightning arrester provided with heating coils, as shown in Fig. 4, is commonly used. Vacuum lightning arresters can also be combined with special coarse and fine safety fuses (Fig. 5). Their dimensions are so chosen as to allow of their being readily substituted for any existing lightning arresters.

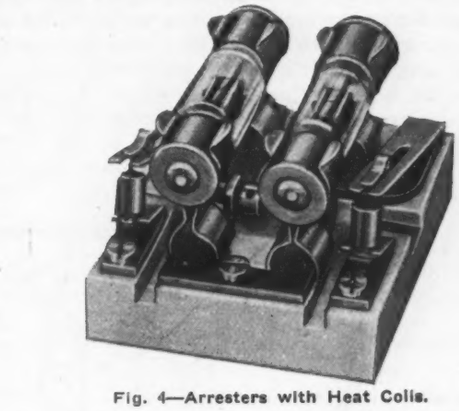


Fig. 4—Arresters with Heat Coils.

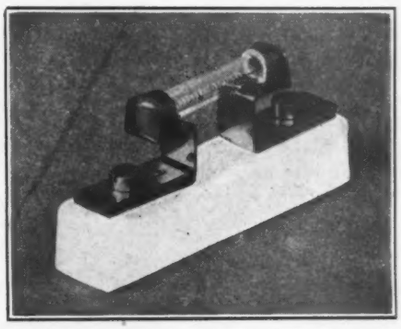


Fig. 5—Combined Arrester and Fuse.

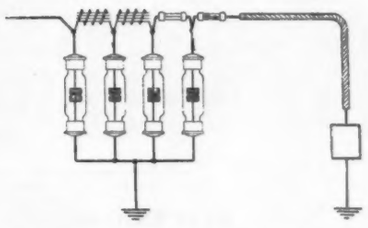


Fig. 7—Arrester for Submarine Cable.

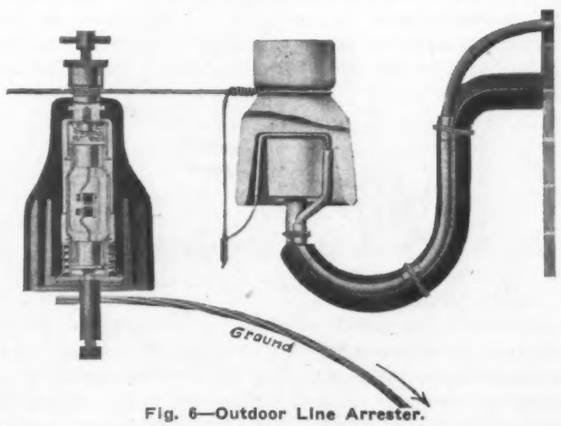


Fig. 6—Outdoor Line Arrester.

The same type of apparatus is used to an ever-increasing extent as transmission-line lightning arrester in the place of the rod apparatus, the cartridge being located in a hard-rubber protective bell. Fig. 6 represents the arrangement of such transmission-line lightning arresters.

The use of self-induction coils and coarse and fine safety fuses, in combination with vacuum lightning arresters (Fig. 7), is indispensable for the protection of submarine cables against injury by atmospheric electricity, with a view to avoiding any

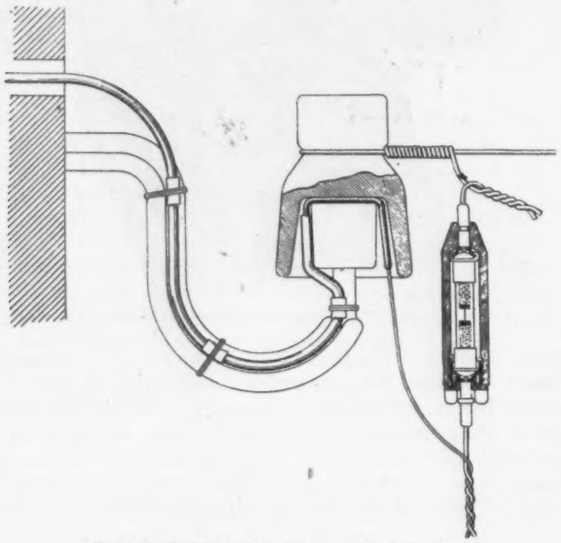


Fig. 8—Combination Fuse and Arrester.

repair, which in that case would involve much difficulty and a considerable expenditure. Fig. 8 represents a cartridge fuse designed for use in the overhead line immediately before its entrance into the building. This arrangement prevents any earth connection, produced on the house side of the lightning arrester, from exerting any dangerous effect, the fuse interrupting at the proper moment the path leading the current into the interior of the building.

ELECTRIC HEATING DEVICES.

In the line of electric heating devices illustrated herewith, the manufacturer, The Diamond Electric Company of Binghamton, N. Y., claims to have given special attention to obtain long life of the heating element, simplicity of construction, convenience of operation, attractiveness of design and low power consumption. In the company's air heater, the heating element is supported at the bottom only and is free to expand independent of the tubes. All connections are at the bottom

Fig. 1—Combination Set.

and a three-heat switch is supported on the base. The combination set illustrated in Fig. 1 comprises a stand with removable heater into which may be set a tea kettle, a coffee percolator or cereal cooker. This cooker is separable and may be used for many purposes. An egg rest or holder is also supplied holding six eggs for boiling. The outfit is furnished in polished nickel, copper or brass, tin lined.

The domestic laundry and tailor irons, it is claimed, will not burn out if left in circuit over night. The heating element in these devices consists of a long length of large cross-section conductor which is free to expand and contract. The metal surrounding the heating element is homogeneous with that of the ironing surface. A large storage effect permits the iron to be used fully 20 minutes after the circuit has been opened and the stand has an angular plate beneath for reflecting the heat from the ironing cloth. The irons are made with permanent or plug attached cord and with a three-heat switch supported at the back.

The "Delco" oven is built entirely of sheet metal with air wall insulation double at top and bottom. A downward reflecting plate above the upper element disposes of the natural accumulation of superheated air at the top and protected glass doors give an attractive appearance to the device. A feature of the oven is a three-heat switch so located that it serves as

Fig. 2—Laundry Iron.

a terminal block. The ovens may be used as plate warmers and for many industrial purposes.

Percolator heaters are made in various styles applicable to all standard makes of percolators. They are interchangeable with the alcohol lamp and clamp to the bottom of the pump or water chamber by screw pressure. The heaters are furnished separately or complete with any standard make of coffee machine. The feature of the percolator heaters is that they can be applied to standard productions without change of any nature.

The soldering copper made by the Diamond Company is made of dull-nickeled brass, excepting the copper tip and ebonoid handle. Removable tips of any shape are supplied for soldering, branding, etc. When too hot the plug can be slipped off and the copper used for soldering for some time without being in circuit because of the heat storage capacity of the device. The construction is such that all projecting screws heads are eliminated leaving the contour smooth its entire length.

Fig. 3 shows the company's toaster which is of the glowing, horizontal radiant type. It is serviceable and makes a dainty appearance on the table with its white porcelain base, polished nickel frame and green silk attachment cord. Bread, cheese, crackers, marshmallows, etc., can be toasted upon it. The company also builds wax or solder pots in a single casting, comprising pot and legs mounted upon a slate base. The heater is secured under the bottom of the pot, the heat being transmitted through but one thickness of metal. Wax ladles and other conveniences are made to accompany the outfit.

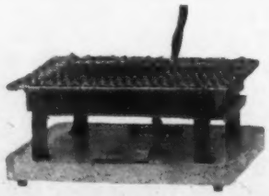


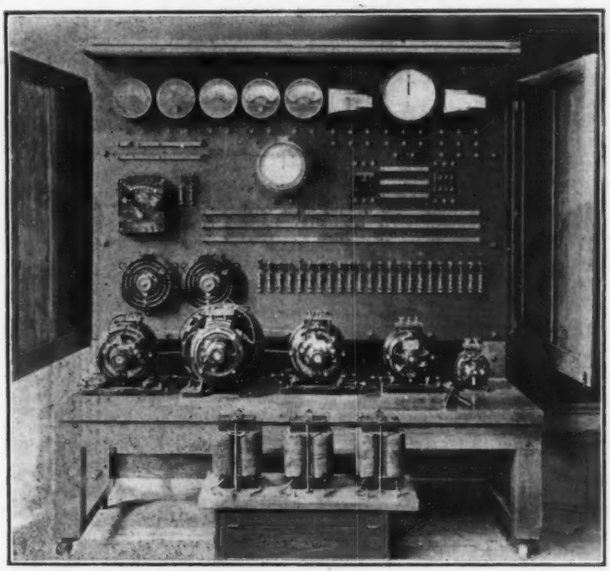
Fig. 3—Toaster.

LABORATORY SET FOR CHICAGO ELECTRICAL WORKERS' UNION.

One of the most interesting, and it may be said significant, electrical laboratory and testing sets installed in Chicago recently is that illustrated herewith, which has been constructed by the Holtzer-Cabot Electric Company for Local No. 134 of the International Brotherhood of Electrical Workers. The Electrical Workers' Union has realized that in order to raise the standard of workmanship and promote the welfare of its members, it should furnish some method whereby the men may become familiar with all ordinary kinds of apparatus with which they are likely to come in contact in the various branches of their work. With this in view, the laboratory set illustrated was ordered and has been built after the examining committee of the union had carefully considered the question.

The set consists of a switchboard with various measuring and other instruments, dynamos, motors, etc. It is intended to be used in educational work, and particularly in the examination of new members, so that, theoretically at least, the union may be assured that all new members are competent to handle any ordinary kind of electrical work, including the connecting up of machines for both alternating and direct current, and the making of all ordinary switchboard connections.

The vertical switchboard itself is made of ebony asbestos panels, on an angle-iron frame, and is supported by a heavy



Laboratory Set.

oak table, carrying motors and dynamos, the whole being made up as a unit and mounted on rollers so that it may be transported from one room to another as desired. The board is so constructed that the instruments cannot be tampered with when not in use. This is accomplished by means of paneled enclosing doors that may be locked when so desired.

Referring to the illustration and reading from left to right, beginning at the top, the switchboard is equipped with instruments as follows: Three ammeters, two for alternating current and one for direct current; two voltmeters, one for alternating current and one for direct current; one single-phase indicating wattmeter; one three-phase, three-wire synchronism indicator; one power-factor meter; one frequency indicator. All of the terminals of the instruments named are brought out to screw connections on the front of the board, so that all connections may be made on the front of the board. Normally, the instruments are not connected, and it is the duty of the man taking the test to make the connections in plain view of those conducting the examinations.

On the table are mounted five machines, as follows, reading from left to right: One three-phase, 110-volt, 60-cycle, revolving-field, alternating-current dynamo; one 110-volt, compound-wound, direct-current motor; one three-phase, 110-volt, 60-cycle, revolving-field, alternating-current dynamo; one 110-volt, 60-cycle, three-phase motor; one 110-volt, 60-cycle, single-phase motor.

The electricity used for this testing set is direct current. All of the different winding terminals of the machines mentioned are brought out to screw terminals, mounted on headboards so that it is possible to examine or test the different windings very easily. The direct-current motor is equipped with two pulleys so that it can be used to drive either or both of the three-phase dynamos. The three-phase motor is also equipped with a pulley for driving one of the three-phase dynamos. On the upright portion of the board, and mounted in front, as shown, are the necessary switches, busbars, controllers, etc.

In the illustration, on a bench, is shown a bank of three transformers. The ends of the different windings of these transformers are brought out to screw terminals, so that these transformers may be connected for delta or star connection very easily.

This unusually interesting educational laboratory set was designed by Mr. R. C. Gault, of the Chicago office of the Holtzer-Cabot Electric Company, and it was built in the Chicago office of the company named, under the direct supervision of Messrs. James B. Wilson and Harvey Ravens, of Local No. 134, International Brotherhood of Electrical Workers. It is now in use by the union at the headquarters of that organization at 275 La Salle Street, Chicago.

SNAP-SHELL LAMP SOCKET.

The lamp socket illustrated herewith known as the Weber "Universal" socket and marketed by Henry D. Sears, of Boston, Mass., is of the snap-shell type. The feature of the socket is that the shell and cap will snap together in a great number of positions so that it is not necessary to guide the projection on the shell in a slot of the cap as heretofore. The shell and cap are securely locked against accidental separation in every position and when together it is immaterial whether they are locked against relative rotation. Under a rotative force the

Snap-Shell Lamp Socket.

shell can move but slightly before the lock against rotation works automatically.

The manufacturer calls attention to the substantial construction of the body of the Weber socket. No screws are used to hold the working parts which are securely clamped in position between two solid blocks of porcelain. With the exception of the binding screws, the two screws which hold these blocks together are the only ones in the socket. The binding screws are sealed in place and in any case there is no strain upon any of the screws, so that they have no tendency to become loose. The cam which makes and breaks the circuit works between two flexible spring contacts and subjects the screw shell to no strain whatever. The center contact spring is made of tough brass and holds the lamp well under tension. The design permits the socket to be wired or dismantled in a minimum of time.

Industrial and Commercial News

The Week in Trade.

TRADE last week, taken as a whole, was very quiet. The unfavorable weather and uncertain crop outlook have bred a spirit of conservatism that was noticeable in all lines. While the feeling in financial circles is more cheerful, there is an undeniable slackening in many lines of manufacture, and retail business throughout the country is only fair. As far as the wholesalers and jobbers are concerned, they are doing little except in filling orders. While there is little feeling of discouragement anywhere, it is apparent that Eastern trade centers are more optimistic than those in the West, which are immediately dependent upon crop returns. Planting has been retarded, and in many sections the weather has been decidedly unseasonable. Among the industries, the one that is progressing most favorably is that of building and outside construction. Reports of building for the month of April, collected from 109 cities, show a total of $93,604,514, a sum only exceeded in the past by the month of May, 1909. The gain over the previous months of the year was very considerable. Pig iron remains inactive, over-production still acting as an adverse factor in the market. In the iron and steel industry there continues to be a very heavy business in structural material and in implements. Collections are still slow, due in a large measure to the retarded spring trade, and many wholesalers are complaining of trouble in this direction. Land speculation, which earlier in the year had been very active in the far West, has received something of a check owing to the higher rates which are being demanded for loans. Business failures for the week which ended May 12, as reported by Bradstreet, were 216 as against 191 the previous week, 224 in 1909, 218 in 1908, 184 in 1907 and 161 in 1906.

The Copper Market

SPECULATIVE campaigns which were inaugurated in the copper market last week were only successful from the operator's standpoint. They succeeded in strengthening prices to some extent, and no doubt created a better tone than that which has existed during the past month, but as far as stimulating actual purchases of copper by domestic consumers they were a failure. On the contrary, many consumers were made distrustful of the future by the apparent manipulation, and were inclined to withhold orders that might otherwise have been placed. Nearly all of the business that has been done since the first of May has been at lower prices than those quoted by the Amalgamated interests. The independents, it is well known, have been shading prices in order to dispose of copper, and the majority of the sales have been made by these interests. For a few days last week the price of speculative contracts advanced, but profit taking at once became so active that there was a sharp reaction. The feature of the week in the copper market was the disposal of the Original and Stewart properties in the Butte district to the Amalgamated interests. These properties belonged to Senator W. A. Clark, and have been added to the Anaconda holdings in that district. Their present production is at the rate of about 24,000,000 lb. a year. This output, added to that of the other companies that are being taken into the Anaconda merger, brings the total output of the enlarged company up to about 325,000,000 lb. a year. The statistical outlook is altogether in favor of the consumer of copper. Production continues at a rate far in excess of actual consumption, and there is no intimation that any agreement will be made looking toward curtailment. The surplus stock of copper it seems will inevitably increase, and whether this is shown by the figures given out by the Association, or whether consumers purchase heavily and carry a portion of the surplus, it really makes no difference. The plain fact is that more copper is being produced every month than is being melted. For the present month, including May 16, the exports of copper have been 8,547 tons. The daily call on the metal exchange May 16 quoted standard copper as per the accompanying table.

Standard Copper.	Bid.	Asked.	Settling price.
Spot	12.25	12.50	.....
May	12.25	12.50	12.37½
June	12.25	12.50	12.37½
July	12.25	12.50	12.37½

The London market May 14 was as follows:

	*Noon. £ s d	*Close. £ s d
Standard copper, spot	56 1 3	Closed.
Standard copper, futures	56 18 9	Closed.

*Holiday.

Extreme fluctuations for this year:

Standard	13.50c.	12.05c.
London, spot	£62 0 0	£55 2 6
London, futures	65 18 9	56 2 6
Best selected	65 10 0	59 10 0

Industrial and Commercial Notes

Cutler-Hammer Company Acquires Kohler System of Control.—It is announced that the Cutler-Hammer Manufacturing Company of Milwaukee, maker of electric controlling devices, and Kohler Brothers of Chicago, contracting electrical engineers and owners of the patents covering the Kohler system of automatic push-button control for printing-presses, motor-driven tools, etc., have entered into an arrangement whereby the Cutler-Hammer company will hereafter manufacture and market, for Kohler Brothers, in the United States and Canada, the various types of push-button operated controllers comprised in the Kohler system. For the purpose of carrying this arrangement into effect, all data and records appertaining to the Kohler system have been transferred to the Cutler-Hammer company. The latter has retained the services of the men who have been handling this branch of Kohler Brothers' business, thus insuring a continuance of expert supervision by engineers thoroughly familiar with the Kohler system of control and its application to printing presses and other classes of motor-driven machinery.

United States Light & Heating Company.—Construction work is being rushed on the new plant of the United States Light & Heating Company, at Niagara Falls, on account of the insufficient capacity of the present plants of the company to fill the outstanding orders. It is said that the new plant will be run 24 hours a day throughout the year, and will eventually give employment to between 3500 and 5000 men. The initial plans call for about 15 separate buildings, to be constructed largely of concrete and brick. Many important railroads, it is said, have recently made contracts for the installation of the "axle" system of car lighting which this company manufactures. It is said that the new plant at Niagara Falls will be the largest manufactory in the world for all kinds of storage batteries.

Electrical Construction.—Among the items printed under Construction News in our present issue are announcements of proposed new plants or considerable extensions of present plants at Searcy, Ark.; Raymond, Minn.; Independence, Kan.; Newton, Ia.; Akron, Ohio.; Crivitz, Wis.; West Palm Beach, Fla.; Meridian, Miss.; Havelock, Neb.; Roseville, Cal.; Jacksonville, Fla.; Superior, Wis.; Estavan Sask, Can.; Independence, Mo.; Kersey, Col.; Medford, Ore.; Memphis, Tenn.; Dublin, Ga.; Bayou La Patre, Ala.; Cyrene, Ga.; Graniteville, Cal.; Toronto, Ont., Can.; and North Brookfield, Mass.

United States Motor Company.—It has been announced that the United States Motor Company, the $16,000,000 automobile combination in the formation of which the firm of J. P. Morgan & Company took an active part, is negotiating for the purchase of the Brush Runabout Company of Detroit. The United States company recently acquired the Columbia Motor Company, and owns among its other subsidiaries the Maxwell-Briscoe Company and the Pope-Toledo Company. It is planned to build another plant in Detroit, which will be devoted to making commercial vehicles.

E. E. Witherby Company.—The E. E. Witherby Company, the organization of which was referred to in the May 5 issue, intends to go into the field as an operating as well as a holding concern. At the present time the only company which it controls is the Shamokin (Pa.) & Coal Township Light, Heat & Power Company. The Witherby company owns a large interest in the stock of this concern, and has a long time contract for its operation. Negotiations are now pending for control and operation of a number of electric and gas concerns.

Moving Platforms in New York.—Now that the rapid transit law has been amended so as to permit the construction of moving platform subways, the Continuous Transit Securities Company is preparing to renew its application to the Public Service Commission and Board of Estimate for permission to "try out" this system of transportation in an experimental subway. The commission has suggested that the system might be tried under Broadway from Tenth Street to Forty-second Street, but the Board of Estimate is of the opinion that it had better first be tried under Thirty-fourth Street between Second and Ninth Avenues. The company proposes to install four parallel platforms moving at three, six, nine and 12 miles an hour respectively. The entire length of the fastest platform will be equipped with regular car seats, and there will be no provision made for standing passengers. Max E. Schmidt is president of the company, and among those interested in the concern are: E. P. Ripley, president of the Atchison, Topeka & Santa Fé Railroad; Moses T. Pyne, Cornelius Vanderbilt; Roberts Walker, president of the Rock Island Railroad; Gen. Chas. W. Raymond, chairman of the board of engineers of the Pennsylvania Tunnel & Terminal Company, and Stuyvesant Fish. Speaking of the enterprise, Mr. Walker said: "The Public Service Commission will never have to ask the moving platform company to put on more trains or provide more seats. The platforms will have twice the capacity of the present subway, express and local trains combined, and will operate at their full capacity at all times. Every passenger will have a seat, and there will be no straps. There will be no problem of side doors or bad car atmospheres. There will be no opportunity for passengers to fall through openings or in front of trains, or to come in contact with live rails, the moving platforms covering the entire track. They will require no signals and no train dispatchers. There can be no collision. The train is continuous and the same at all hours."

Columbia Gas & Electric Company.—The board of directors of the Columbia Gas & Electric Light Company, of Cincinnati, recently organized by the re-election of Archibald White as president. The other officers are as follows: Vice-presidents, James C. Ernst, F. B. Enslow and R. W. White; secretary and treasurer, W. T. Hunter; executive committee, A. S. White, J. C. Ernst, F. B. Enslow, W. T. Hunter, J. M. Hutton, Norman G. Kenan and R. W. White. C. H. Beardslee resigned as a member of the board of directors and Andrew Squire, of Cleveland, was chosen to succeed him. President White stated that the earnings for the first quarter were beyond his expectations and that if they continued through the year in the same proportion, dividends on the common stock are almost in sight. By the consolidation of several departments and other economic steps the company will probably save $100,000 during the year and this will bring the net receipts up in good shape. Mr. White has refused the salary of $25,000 a year appropriated to him by the board of directors and in a letter to them, while expressing his appreciation of their act, states that he has no intention of drawing a salary until the company is paying dividends upon its common stock. The same salary, voted to him a year ago, is still in the treasury. Mr. White says he has a higher ambition in connection with the company than drawing a big salary as president.

Orange County Lighting Company.—The improvements to be made upon the generating station of the Orange County Lighting Company, Middletown, N. Y., which were referred to in our issue of May 5, embrace an addition to the engine room, 50 ft. by 68 ft., the installation of a 640-hp cross-compound Corliss engine built by the Ball & Wood Company, of Elizabethport, N. J., directly connected to a 500-kw generator made by the General Electric Company, and the installation of two 350-hp Babcock & Wilcox boilers. The General Electric Company will also install a new switchboard and auxiliary electrical apparatus. A motor-operated conveyor made by the Jeffrey Manufacturing Company, Columbus, Ohio, will be installed for unloading coal cars, and a 10-ton overhead traveling crane, from the Niles Tool Company, will also be constructed. Plans for these improvements were made by W. S. Barstow & Company, of New York, engineers. The plant when completed will have a total capacity of 1300 hp, and the generating station, which was formerly the property of the Consumers Light & Power Company, will be used only as a reserve plant. In addition to these steam plants, the company has available about 400 hp from the hydroelectric plant of the Orange County Power Company on the Neversink River. The company serves a total connected load of 22,000 incandescent lamps, and 375 hp in electric motors.

Automobile Business Enlarging.—From the fact that practically every automobile concern in the country has found it necessary to improve and enlarge its plant, it is evident that the manufacture of motor vehicles has not suffered any depression so far this year. It is said that the gross earnings actually received during the first three months of 1910 by the automobile makers were approximately $50,000,000. The pressure of the business has been so great that serious difficulties have been experienced in securing enough freight cars to handle the traffic. The Lewis Spring & Axle Company, of Jackson, Mich., has doubled its plant; the Pierce-Arrow Motor Car Company, of Buffalo, has erected three large additions to its factories; the Winton Motor Carriage Company, of Cleveland, is adding a three-story structure 308 ft. by 70 ft., and the American Tube & Stamping Company, of Bridgeport, Conn., has purchased 10 acres of land and will add another factory with 125,000 sq. ft. of floor space. It is said that Detroit, which has 23 concerns manufacturing automobiles and parts, will produce 85,000 cars during 1910. The Detroit companies have a total capitalization of $30,000,000, and give employment to about 58,000 workmen.

Long Island Railroad Electrification.—Active work has been commenced on the electrification and double-tracking of the North Shore Division of the Long Island Railroad, between Flushing and Port Washington. Several thousand feet of track were laid last week, and operations on the lines between Winfield Junction, Flushing, Whitestone Landing and Malba will be begun as soon as the plans for the elimination of grade crossings have been completed. The elimination of these crossings will entail a cost of about $1,000,000, half of which will probably be borne by the city. The power for the entire North Shore Division will be supplied through two transforming stations, sites for which have been secured at Whitestone and Little Neck. The railroad officials say that the delay in opening through service to Manhattan by way of the Pennsylvania tunnels has been occasioned by the difficulty in securing the new steel cars, which should have been delivered several months ago. The operation of tunnel service as far as Jamaica is definitely assured before August 1.

Rehabilitation of Automatic Telephone System in Chicago.—According to representatives of the telephone department of the Illinois Tunnel Company of Chicago, contracts for the installation of new automatic instruments are being taken at a rate which will mean 10,000 subscribers by the first of June. The company has a year in which to install 20,000 stations. Everything connected with the system, except the cables in the tunnels, is to be new. At first only business telephones will be installed, and the rate will be $84 a year for unlimited service. If 20,000 telephones are installed at this rates, the gross income will be $1,680,000. Deducting $420,000 for operating expenses, $50,400 for the city's 3 per cent of the gross receipt, $209,600 for taxes and depreciation, the net income, according to these estimates, will be $1,000,000, equal to 5 per cent on $20,000,000 of bonds.

Interborough Buys Westinghouse Motor Equipments.—The Interborough Rapid Transit Company has just placed an order with the Westinghouse Eectric & Manufacturing Company for the motor equipment of its new subway and elevated cars. The order consists of 188 motors with controls, wiring, etc., for the subway division and 120 motors and controls for new elevated cars. In addition to this the same company has sold to the Interborough company 1,000 line switches and various minor appliances.

Rateau-Smoot Turbines for Illinois Steel Company.—The Illinois Steel Company, one of the constituent companies of the United States Steel Corporation, has recently awarded a contract to the Ball & Wood Company for the installation of two 3000-kw Rateau-Smoot, mixed flow turbines, each to be directly connected to a 3000-kw, 25-cycle, 2200-volt, 3 phase, alternating-current generator. These units are to be installed at the South Works, Chicago.

Illinois Traction System.—As stated in the issue of April 21, the rate war that has been waging between the Illinois Traction System and the steam railroads of southern Illinois has been settled by arbitration. The rates that have been agreed upon are on the basis of 2 cents a mile for single trips; round-trip rates, with a ten days' limit, double the single fare less 10 per cent; excursion rates one and one-half fares.

Heavy Demand for Platinum.—There has been an unusually heavy demand for platinum during the past few months, but prices have held fairly steady. At the present time platinum is sold at about $29.50 an oz. One of the principal importers says that the recent stories that Russia was about to put an export duty on platinum, and to fix a minimum price, have had no effect upon the American market. He says that the Russian government has threatened so many times to take control of the platinum industry, and has failed to do so, that American importers have lost faith in these rumors. All of the arts using platinum are apparently prosperous, and dental manufacturers, who are the principal users, seem to be doing a larger business than ever before.

Financial.

The Week in Wall Street.

DWINDLING business was the characteristic of the Wall Street stock market during the past week. Every day seemed to be duller than the one previous, and at times the sound of the ticker was entirely absent from the offices of the brokers. Long periods between sales caused considerable depression among the commission houses. The outside public appears to be entirely out of the market, and neither trades in stocks nor invests in bonds. In spite of this condition of stagnation, prices have advanced during the week several points, and there seems to be no selling pressure and no bear organization in the trading. All of the active stocks have made gains, and this in itself indicates that the real tone of the market is not unsatisfactory. There is little doubt that some heavy money transactions have been put through by American bankers in the European market. Large flotations have been made, and it is said that St. Paul, Baltimore & Ohio, Southern Railway, the Big Four and Frisco lines have all placed securities. How extensive the sale of American securities abroad has really been is hard to say. The optimists claim that it will reach $150,000,000, while the pessimists admit that it will be at least $75,000,000. There is apparently plenty of cash in the banks, and loans are made liberally to conservative operators. The quotations May 16 were: Call, 3½@4 per cent; 90 days, 3¼@4 per cent. The quotations in the table are those at the close May 16.

NEW YORK.

	May 9.	May 16.	Shares sold.		May 9.	May 16.	Shares sold.
All.-Ch.	9⅞	9⅝	472	Int.-Met., pfd.	55⅛	55⅛	31,400
All.-Ch., pfd..	35	34*	300	Mackay Cos..	86	89	500
Amal. Cop...	67⅞	71½	222,920	Mackay C., p.	75¾	76	142
Am. D. T....	20½*	20½*	———	Man. Elev...	135½	136*	1,230
Am. Loc.....	49¼	49¾	3,415	Met. St. Ry..	15	15*	———
Am. Loc., pfd.	110*	110*	———	N.Y.&N.J. Tel	139¼*	139¼*	———
Am. Tel. & C.	75*	75*	———	Steel, com...	82¾	83⅜	502,320
Am. T. & T..	135⅜	137	6,600	Steel, pfd....	118	118¼	11,320
B. R. T.....	78¾	80½	121,470	W. U. T....	68	68⅜	1,550
Gen. Elec....	147½	149¾	2,200	West'h., com.	63½	64½	2,000
Int.-Met., c'm.	21	20½	16,700	West'h., pfd..	110*	110*	———

PHILADELPHIA.

	May 9.	May 16.		May 9.	May 16.
Am. Rys.....	45	45	Phila. Elec.....	15⅛	15¼
Elec. Co. of A.....	11⅜	12	Phila. R. T.....	18⅛	20¼
Elec. St. B'ty.....	58½	59¼	Phila. Trac.....	85*	86½
E. S. B'ty, pfd.....	30*	30*	Union Trac.....	47⅜	49

CHICAGO.

	May 9.	May 16.		May 9.	May 16.
Chi. City Ry.....	180*	180*	Chi. Tel. Co.....	119	114⅞
Chi. Rs., Ser. 1....	99*	99*	Met. El., com.....	16*	19*
Chi. Rs., Ser. 2....	28¼	28¾*	Met. El., pfd.....	57¾	58
Com. Edison.....	113	113*	Nat'l Carbon.....	108¾	108¾*
Chi. Subways.....	2½	2½*	Nat'l Car., pfd.....	119	115

BOSTON.

	May 9.	May 16.		May 9.	May 16.
Am. T. & T.....	135⅜	137	Mex. Tel.....	6½	6¾
Cum. Tel.....	145*	146	Mex. Tel., pfd.....	6¼	7
Edison E., Ill.....	249	250¼	N. E. Tel.....	133	134
Gen. Elec.....	147	148¼	W. T. & T.....	15½*	16
Mass. E. Ry.....	18	18	W. T. & T., pfd....	86	86*
Mass E. Ry., pfd...	85½	86			

* Last price quoted.
Shares sold for week of May 9 to May 14.

Financial Notes.

Columbia Power & Light Company.—The details of the purchase of the Northwestern Corporation by the Columbia Power & Light Company, which belongs to the H. M. Byllesby Company, and which was referred to in the issue of May 5, have just been made public. The Columbia Power & Light Company was recently incorporated under the laws of Idaho, and the purchase of the Northwestern Corporation involves about $3,000,000. The transfer includes gas plants, franchises and contracts at Walla Walla and Pendleton, Oregon, and North Yakima, Wash., and electric light systems and franchises at Dallas, Independence, Monmouth, Albany, Corvallis, Eugene and Springfield, Oregon, together with gas plants at Eugene and water works at Independence, Albany and Springfield. The Byllesby Company has recently obtained control of the gas and power plants at Olympia, Tacoma and Sand Point, Idaho, and will take over the Coos Bay gas and electric plants, and the street railways and the Condor Light & Power Company now held by the Northwestern Corporation. The Northwestern Corporation furnishes light and power for Ashland, Medford, Grant's Pass and Jacksonville in Southern Oregon. The Columbia Light & Power Company has also purchased from Robert E. Strahorn, of Spokane, president of the North Coast Railway Company, the Northwest Light & Power Company of North Yakima, which serves Mabton, Toppenish, Sunny Side, Prosser, Kenewick and Pasco, Wash. It is said that the high-tension lines will be extended from Pasco to Walla Walla. The holdings of the Northwestern Corporation in the neighborhood of Walla Walla, which were recently taken over by the America Power & Light Company, will be transferred to the Columbia company.

Wireless Telegraph Companies Merged.—Announcement has been made at Detroit that the Clark Wireless Telegraph-Telephone Company, the Collins Wireless Telegraph Company, Newark, N. J., the Massie Wireless Telegraph Company, Providence, R. I., and the Pacific Wireless Telegraph Company, of San Francisco, Cal., have been merged into one company called the Continental Wireless Telephone & Telegraph Company, the organization of which was announced in the issue of May 5. Thomas E. Clark is the promoter of the consolidation. The Clark Company has stations at Detroit and at several lake ports in that section, and has its apparatus upon several lake steamers. The Collins Company has a station at Newark and one at Philadelphia, but it is not known that it has transacted any commercial business. The Massie Company has a station at Providence, and has its apparatus upon the Fall River Line operating in Long Island Sound. The Pacific Wireless Telegraph Company is said to have several stations on the Pacific Coast.

Doherty Buys Bristol Gas & Electric.—Henry L. Doherty & Company have purchased a controlling interest in the stock of the Bristol (Tenn.) Gas & Electric Company. The interests purchased were those held by C. M. Warner and W. A. Williamson, of New York. Henry L. Doherty and H. H. Scott, connected with the Doherty firm, have been elected directors of the company, and Mr. Doherty has been chosen president. The company is capitalized at $300,000 and has an authorized issue of $425,000 bonds. It controls the gas and electric business of Bristol, Tenn. and Virginia, and owns practically all of the capital stock of the Bristol Belt Line Railroad Company.

Westinghouse Lamp Company.—Notice is given that a meeting of the stockholders of the Westinghouse Lamp Company will be held June 1 for the purpose of voting upon the question of issuing $1,000,000 of 7 per cent cumulative preferred stock, and to fix the terms under which the stock shall be issued. The Westinghouse Lamp Company was originally the Sawyer-Man Electric Company, and is the lamp department of the Westinghouse Electric & Manufacturing Company. It has an authorized capitalization of $2,500,000. No announcement as to the purposes to which the proceeds of the proposed issue are to be put has been made.

Brooklyn Rapid Transit Dividends.—At a meeting of the directors of the Brooklyn Rapid Transit Company last week, the quarterly dividend on the stock was increased from 1 per cent to 1¼ per cent, making the annual basis 5 per cent. The initial dividend of 1 per cent quarterly was declared in February, 1909. According to the recently published figures of earnings for the six months which ended Dec. 31, 1909, the company earned 3½ per cent, or at the rate of 7 per cent for the entire year.

Northwestern Telegraph Company.—At the meeting of the stockholders of the Northwestern Telegraph Company, held at Kenosha, Wis., last week, the control of the property was formally turned over to a syndicate of capitalists living at Hartford, Conn. New directors were elected representing the new interests, the leader of which is Francis R. Cooley, of Hartford. The Northwestern company has been operated by the Western Union Telegraph Company for many years.

Chicago Telephone Rates.—The accountants of the city of Chicago, who have been checking up the operations of the Chicago Telephone Company under the new ordinance, have prepared a preliminary report which shows that the company is earning only 3.83 per cent on its city business at the present time. These figures take no account of the operations outside of Cook County. The report shows that for the year ending March 31, the gross revenue of the company was $7,864,771, the operating expenses $6,973,796, leaving a net revenue of $890,975. The interest and dividends paid were $1,799,518, which creates a deficit of $908,536 for the year. The report also shows that the nickel-a-day residence telephones, of which there are 72,983 in use, are operated at a loss of more than $5 per year for each 'phone. Under these circumstances it is not thought likely that the city council will advise a reduction of rates.

Metropolitan Street Railway Reorganization.—When the property of the Metropolitan Street Railway system was offered at foreclosure sale last week, the upset price being $10,000,000, there was no bid for it. A representative of the reorganization committee of bondholders was present, and had deposited certified checks which would have authorized him to bid, but as no other bidder appeared he declined to make an offer. After the Master had declared the sale a failure, the representative of the bondholders' committee made a statement in which he said that the reorganization plans for the property were very nearly completed, and that both issues of bonds were represented in the reorganization committee.

New York Central Subsidiaries Paying.—The New York State Railways Company and Mohawk Valley Company, subsidiaries of the New York Central Railroad Company, have each declared an initial dividend of 1½ per cent. These two companies control various electric railway and lighting properties in New York State. Following the announcement of the dividends the declaration was made that the syndicate formed by the New York Central and other interests, to take up the minority stock in these corporations, had been dissolved, and that the share holdings had been distributed among the individual members of the syndicate.

Otis Elevator Company.—The annual report of the Otis Elevator Company for the fiscal year which ended Jan. 31, 1910, shows that the business of the company had vastly improved over the two years previous. The net returns were $1,048,689, as compared with $832,772 the previous year. After paying the regular 6 per cent dividend upon the $6,310,000 preferred stock, there remained a surplus equivalent to more than 10 per cent on the common stock. During the year a new foundry and warehouse were added at the Yonkers works, and additional shops were also built at the same place.

United Railways of Chicago.—Charles G. Dawes, chairman of the reorganization committee of the Chicago Consolidated Traction Company, has announced that application will be made within a few days to the City Council for a franchise for the United Railways Company of Chicago. This is the new corporation which is to take over the North Side suburban lines of the old Consolidated company. It is expected that the new corporation will receive a twenty-year grant on terms of joint ownership, similar to the ordinances of the other local traction companies.

Southern Power Company.—A mortgage has been filed at Spartansburg, S. C., by the Southern Power Company for $10,000,000, covering its recent bond issue. The mortgage is given to the Farmers Loan & Trust Company of New York, and is dated March 1, 1910. The proceeds are to be used for the construction of new plants, the acquirement of additional hydroelectric properties and the promoting of an electric line from Anderson, S. C., to Charlotte, N. C.

Montana Properties Change Hands.—S. M. Gibo, president of the Lewiston (Mont.) Gas & Light Company, has purchased the plants and holdings of the Citizens' Electric Company, of Lewiston, and the Spring Creek Power & Electric Company, both of which were owned by John L. Bright. It is understood that the deal represents about $250,000. The two companies have been reorganized with David Hilger as president and Mr. Gibo as vice-president.

DIVIDENDS.

American Railways Company, quarterly, 1½ per cent, payable June 15.

Brooklyn Rapid Transit Company, quarterly, 1¼ per cent, payable July 1.

Columbus (Ohio) Railway Company, quarterly, 1¼ per cent, payable June 1.

International Smelting & Refining Company, quarterly, 2 per cent, payable June 1.

Kellogg Switchboard Company, quarterly 2 per cent, extra 1 per cent.

Kings County Electric Light & Power Company, quarterly, 2 per cent, payable June 1.

Mohawk Valley Company, initial, 1½ per cent, payable July 1.

New York State Railways Company, initial, 1½ per cent, payable July 1.

Philadelphia Electric Company, quarterly, 1½ per cent, payable June 15.

Portland (Ore.) Railway, Light & Power Company, quarterly, 1 per cent, payable June 1.

REPORTS OF EARNINGS.

	Gross earnings.	Expenses.	Net earnings.	Charges.	Surplus.
American Telephone & Telegraph Company:					
Quarter ended March 31, 1910	$39,533,281	$14,671,395	$24,861,886	$15,262,915	$9,598 971
Quarter ended March 31, 1909	35,273,032	13,551,660	21,721,372	13,849,829	7,871,543
Cape Breton Electric Company:					
March, 1910	20,135	11,615	8,520	5,050	3,470
March, 1909	16,462	11,143	5,319	5,023	296
Colorado Telephone Company:					
Year 1909	2,907,726	2,226,466	681,260	595,000	86,260
Year 1908	2,709,701	1,866,682	843,019	592,769	250,250
Columbus (Ga.) Electric Company:					
March, 1910	33,353	16,525	16,828	13,234	3,594
March, 1909	29,495	15,098	14,397	12,849	1,548
Edison Electric Illuminating Company, of Brockton:					
March, 1910	25,524	12,959	12,565	3,953	8,612
March, 1909	20,480	12,270	8,210	3,220	4,990
El Paso (Tex.) Electric Company:					
March, 1910	51,578	29,564	22,014	8,574	13,440
March, 1909	45,602	29,005	16,597	7,912	8,685
Fairmont & Clarksburg Traction Company:					
April, 1910	44,309	17,181	27,128	12,609	14,519
April, 1909	$4,895	12,644	22,251	12,309	9,942
Houghton County (Mich.) Electric Light Company:					
March, 1910	21,699	11,393	10,306	4,233	6,073
March, 1909	19,771	11,408	8,363	4,124	4,239
Jacksonville (Fla.) Electric Company:					
March, 1910	52,557	26,974	25,583	9,469	16,114
March 1909	41,047	23,591	17,456	9,558	7,898
Keystone Telephone Company:					
April, 1910	95,690	46,152	49,538	....	....
April, 1909	91,046	45,317	45,729	....	....
Northern Texas Electric Company:					
March, 1910	128,679	67,290	61,389	18,786	42,603
March, 1909	109,013	60,358	48,655	17,173	31,482
Philadelphia Company:					
Year 1909	18,239,189	9,541,798	8,697,391	3,419,021	4,117,327
Year 1908	16,576,262	8,681,133	7,895,129	3,340,620	3,428,279
Puget Sound Electric Railway Company:					
March, 1910	157,778	125,177	32,601	50,607	*18,006
March, 1909	142,048	98,928	43,120	45,910	*2,790

* Deficit.

General News

Construction News.

ATTALLA, ALA.—H. A. Rogers, representing the Noccalula Railway, Light & Power Company, has petitioned the City Council for a franchise to construct and operate an electric railway over certain streets in this city.

BAYOU LA BATRE, ALA.—The Alabama Canning Company, recently formed with a capital stock of $180,000, is planning to erect a large canning establishment, for which a site of 32 acres has been purchased. A cold storage plant will be built and an electric light and power plant erected to furnish electricity for lighting and operating the plant. Electrical service will also be furnished to residents of Bayou La Batre.

CUBA, ALA.—L. Poole, Mayor, is reported to have been authorized to give a free site and a subscription of $5,000 for the establishment of a knitting or hosiery mill, backed by reliable parties. Near the town of Cuba an old dam is located, which, it is stated, could be utilized to furnish power for operating the mill and electricity for lighting the town of Cuba.

GENEVA, ALA.—Plans are being prepared by the Geneva & Enterprise Traction Company for the construction of an electric railway from Geneva to Enterprise, for which rights of way are now being secured. It is proposed to erect a power plant on Double Bridge Creek.

SYLACAUGA, ALA.—It is reported that bonds for the construction of an electric light plant in Sylacauga were recently voted. The erection of a transmission line 16 miles in length will be necessary to connect the power plant with the town. S. P. McDonald is Mayor.

GLENWOOD, ARK.—A. A. Alexander, of Glenwood, Ark., it is stated, is installing equipment for a new timber mill, including boiler, engine and power transmission apparatus.

OZARK, ARK.—It is reported that the Mayor would like to receive propositions for the installation of an electric light and ice plant in Ozark, Ark. For further information address Dr. Thomas Douglass, Mayor.

SEARCY, ARK.—Bids will be received by the Board of Public Improvement, of Water District No. 1, until May 25, for construction of water works system, including the construction of concrete surface reservoir, a 60,000-gal. elevated steel tank, an artesian well, a deep-well pump, centrifugal force pumps, water mains, hydrants, valves, etc., and also a 75-kw engine-driven generator, with all accessories. Plans and specifications may be seen and blank proposals secured at the office of the secretary of the Board of Public Improvement, Searcy, Ark., and at the office of the W. S. Shields Engineering Company, 1201 Hartford Building, Chicago, Ill. E. A. Robbins is chairman of board.

BLACK DIAMOND, CAL.—The question of establishing a municipal electric light plant and water-works system in Black Diamond is under consideration.

GLENDALE, CAL.—E. D. Goode, representing the Glendale & Eagle Rock Railway Company, has applied to the Board of Supervisors for a franchise to extend the Eagle Rock car line from the Glendale city limits to Verdugo Park.

GRANITEVILLE, CAL.—Preparations are being made by the Middle Yuba Hydro-Electric Power Company to begin work on its power project on the Middle Yuba River, below Graniteville. The work will include the construction of flumes, ditches, reservoirs and power house. The company proposes to furnish electricity for lamps and motors in Allegheny County.

MARYSVILLE, CAL.—Plans are being considered by the Pacific Gas & Electric Company for improvements to its local gas plant at Fourth and Yuba Streets, including a new boiler as an auxiliary to the present one. The company is extending its electric transmission lines farther into Sutter County and other surrounding territory.

NAPA, CAL.—William J. Lindow has presented a petition asking that the franchise granted to the Napa Valley Electric Company for the erection of an electric transmission line be extended one year from Aug. 12, 1910.

RED BLUFF, CAL.—Five notices of appropriations of water, aggregating 52,000 miners' inches of water, have been filed with the county clerk. One application was made by George Morse for appropriation of 20,000 inches, to be taken from Mill Creek, six miles below Morgan Springs. H. M. Parker has filed notice for 20,000 inches, to be taken from Mill Creek, half of it to be taken six miles below Morgan Springs and 10,000 inches 13 miles below Morgan Springs. H. L. Banfield has appropriated 12,000 inches from the south fork of Cottonwood Creek.

ROSEVILLE, CAL.—At an election held recently the proposition to issue $90,000 in bonds, the proceeds to be used for the construction of a municipal electric light plant, sewer system and a bridge across Dry Creek, was carried. The citizens are also considering the question of controlling the city water system.

SAN BERNARDINO, CAL.—The Consolidated Reservoir & Power Company, of San Bernardino, has awarded a contract for the construction of the cement conduit extending from the South Fork of Whitewater River to San Gorgonio Canyon to W. E. Pedley, for $66,750. The water will be used to generate electricity in Jacinto Valley, where several power houses will be constructed.

SAN LEANDRO, CAL.—The People's Light & Power Company has purchased a 30-year franchise in San Leandro, Ca., for which it paid the sum of $56.

SEBASTOPOL, CAL.—The Town Trustees have ordered the franchise applied for by the Russian River Light & Power Company advertised for sale. The company has applied for a franchise to connect the substation of the Pacific Gas & Electric Company in Sebastopol with the line recently erected from this town down the Russian River. John E. Bennett is president of the Russian River Company.

STOCKTON, CAL.—The Board of Supervisors has awarded the contract for installing the lighting system around the court house to the Ruhl Goodell Company for $3,300.

STOCKTON, CAL.—George C. Williams, consulting engineer, has submitted a report to the Board of Supervisors in which he states that the installation of an independent power plant in the county jail would result in a saving of from $1,800 to $2,300 per year.

VALLEJO, CAL.—The City Trustees are reported to have instructed the Board of Public Works to secure estimates on the cost of installing a municipal electric light plant. The trustees are preparing to issue bonds to establish the same.

DENVER, COL.—The Victor American Fuel Company is equipping a number of its mines for electrical operation and is also lighting many of its camps and mines with electricity. Energy for the service is furnished by the Southern Colorado Power Company, delivered at 23,000 volts, which is transformed by the Victor Company to 440 volts, three-phase, and to 110-220-volt for lighting service.

GOLDEN, COL.—The new concentrating plant of the North American Smelter & Mines Company has recently been placed in operation. The machinery is equipped for electric motor drive throughout. The equipment of the power plant consists of two 100-kw Westinghouse generators, each driven by compound engines. J. Hall, of Golden, Col., has charge of the electrical operation of the plant.

KERSEY, COL.—It is reported that a proposition has been submitted to the town officials offering to install an electric light plant and water works system in Kersey, to cost at least $25,000, and at the end of 10 years to sell the plants to the town at a fair appraisal. The proposed plan calls for the driving of deep wells and the erection of a generating plant, work on which will begin within 90 days after the franchise is granted.

HARTFORD, CONN.—Contracts are reported to have been awarded by the Universal Machine Screw Company for the construction of its new shops at Hartford, Conn. The plant will be equipped for electrical operation, power for which will be purchased from the Hartford Electric Light Company.

NEW HAVEN, CONN.—Messrs. Peet & Powers, of New York, N. Y., have been awarded the contract for the installation of the power and heating plant at the New Haven Hospital.

WASHINGTON, D. C.—Bids will be received by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until May 24, for the following supplies: Schedule 2450—Two air compressors, with motors, generators, etc. Schedule 2459—One electrically driven pump.

WASHINGTON, D. C.—Bids will be received until May 21 at the office of the chief signal officer, War Department, Washington, D. C., under proposal No. 456, for furnishing wire and cable as follows: Four miles of cable, type 213; 5000 ft. of cable, type 401; 5000 ft. of cable, type 403; 20,000 ft. cable core, rubber insulated; 1 conductor and 40,000 ft. antenna wire.

JACKSONVILLE, FLA.—R. N. Ellis, superintendent of the municipal electric light plant, in a report submitted to the Board of Bond Trustees, recommends the installation of a 1500-kw generator in the municipal electric plant to provide for the increasing demands for electricity, as the new electric plant will not be completed for some time.

MILTON, FLA.—Bonds to the amount of $40,000 have been voted for the construction of a municipal electric light plant, instead of $5,000, as reported in the issue of May 12. The Solomon Norcross Company, of Atlanta, Ga., has charge of the engineering work.

WEST PALM BEACH, FLA.—The West Palm Beach Improvement Company is reported to be considering the question of installing an electric light plant, bids for which will be received about July 1.

CYRENE, GA.—Z. J. Edge, superintendent of the Bowen Association High School, would like to receive estimates of cost of generator, wiring, fixtures, etc., for about 750 lamps; also for a steam-heating outfit for

dormitory for the Bowen Association High School. The cost of the work is estimated at about $25,000. The contract for the erection of dormitory has been awarded to William Jester, of Cyrene, Ga.

DONALDSONVILLE, GA.—At an election held May 10 the citizens voted in favor of the proposition to issue $20,000 in bonds, the proceeds to be used for improving the water works system and installing an electric lighting system.

DUBLIN, GA.—It is reported that improvements will be made to the municipal electric light plant, which will involve an expenditure of $10,000, and will include the installation of an engine and generator.

FITZGERALD, GA.—The City Council has granted the Bowen Telephone Company a 20-year franchise to operate a telephone system in Fitzgerald, in return for which the company is to pay the city $200 per year for the first 10 years and $500 per year for the second 10 years.

WARRENTON, GA.—The citizens on May 10 voted in favor of the proposition to issue $12,000 in bonds, the proceeds to be used for the installation of an electric lighting system.

WAYCROSS, GA.—The Ware County Light & Power Company, of Waycross, Ga., has applied to the Railroad Commission of Georgia for permission to issue $300,000 in bonds and $100,000 in capital stock.

BOISE, IDAHO.—The Aetna & Atlas Cement Company, it is reported, is planning to construct cement factories and a power plant on the Salmon River, just below the confluence of the Little Salmon River with the Big Salmon River, at an expenditure of about $1,500,000.

HAILEY, IDAHO.—The Picotte ranch, located on Deer Creek, has been purchased by W. W. Chambreau, manager of the Nay Aug group of mines. It is understood that a hydroelectric power plant will be erected on Deer Creek to furnish electricity for lighting the mines and operating the mill, which will be built later on.

STITES, IDAHO.—N. Wayland has applied to the Town Council for a franchise to install an electric light and power plant in Stites.

VANWYCK, IDAHO.—N. Wayland is reported to be contemplating the installation of an electric light and power plant in Vanwyck.

NORTH CRYSTAL LAKE, ILL.—The plant and holdings, with the exception of the telephone system, of the Illinois Lakes Light & Power Company in Crystal Lake and North Crystal Lake and in McHenry County, with contracts and ordinances, have been transferred to the North Shore Electric Company, of Chicago, Ill.

COLUMBUS, IND.—Proposals will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until June 20, for the construction, including plumbing, gas piping, heating apparatus, electric conduits and wiring, of the United States post office building at Columbus, Ind. Plans and specifications can be obtained at the above office and from the custodian at Columbus, Ind.

CYNTHIANA, IND.—At a special election held recently the citizens voted to install an electric light system. Electricity for operating the system will be supplied from Poseyville, four miles distant. It is expected that the farmers living along the road will utilize the service for lighting purposes.

EVANSVILLE, IND.—Plans are being prepared by the Evansville & Boonville Traction Company for an extension of its railway from Boonville through Lynnville and the Pike County oil fields to Oakland City, Ind.

FORT WAYNE, IND.—The Fort Wayne & Wabash Valley Traction Company has discontinued the electrical service furnished by the Indiana Union Traction Company on the lower end of the Bluffton division, and is preparing to erect a permanent substation near Kingsland. At present electricity is furnished by a new portable substation.

HARTFORD CITY, IND.—The United Telephone Company has commenced work on extensive improvements to its rural telephone lines in Blackford County, which will call for the erection of 1000 new poles and 95 miles of wires. The cost of the work is estimated at about $5,000.

JASONVILLE, IND.—The Indiana Electric Transmission Company, which took over the plant and property of the Jasonville Electric Company, is now furnishing a day service in this city.

MISHAWAKA, IND.—Application has been made to the County Commissioners by Neff Brothers, of Milford, Ind., for the construction of an interurban railway from Bremen to Mishawaka, the motive power to be either gasoline or electricity.

OWENSVILLE, IND.—Plans are being made to make the local electric light plant a central generating station for electrical service to all farm houses within a radius of three miles of Owensville. Many of the farmers are planning to generate their own electricity by the installation of generators driven by a gasoline engine.

PARKER CITY, IND.—The Eastern Indiana Telephone Company has decided to rebuild its system in this city, at a cost of about $5,000. New poles will be erected and cables will be used.

RICHMOND, IND.—The County Commissioners of Wayne County have rescinded completely the franchise recently granted to Robert Ashe, giving him the privilege to erect transmission lines to transmit electricity for lamps and motors through all the townships of Wayne County.

TAYLORVILLE, IND.—The engine house of the Taylorville Gas & Electric Company is reported to have been destroyed by fire recently, causing a loss of about $10,000.

WARSAW, IND.—Announcement has been made that financial arrangements have been made for the construction of the proposed Wabash-Warsaw interurban railway by the Wabash & Northern Indiana Traction Company. It is understood that work on the road will begin in the near future.

WINDHAM, IND.—The Shoals & Dubois Telephone Company, recently incorporated, proposes to erect and equip an exchange at Windham and extend its lines through Dubois County. Peter Fuhrman is president of the company.

DES MOINES, IA.—A committee consisting of F. C. Hubbell, B. F. Kaufman and G. W. Hippee, has been appointed to secure the construction of an interurban railway from Des Moines to Red Oak, via Greenfield, a distance of 100 miles.

MONTICELLO, IA.—Arrangements are being made by the Electric & Water Supply Company for extensive additions to its plant. It is proposed to increase the capital stock of the company to $30,000 and to issue bonds to the amount of $100,000 to provide funds for the development of the upper dam.

NEWTON, IA.—Preparations are being made to install a new municipal electric light plant about July 1, which will have a much larger output than the present plant. The equipment of the present plant, including two Detroit generators of 70 kw each, belt-connected to an 18-in. x 36-in. Sioux City engine, will be disposed of to the highest bidder.

OAKLAND, IA.—We are informed that it is proposed to construct an electric light plant in Oakland, at a cost of about $15,000. H. W. Stevens, of Oakland, Ia., is engineer in charge.

INDEPENDENCE, KAN.—The Independence Manufacturing & Power Company is contemplating the installation of a 300-kw electric generating unit, with exciter, switchboard and other apparatus.

LEWIS, KAN.—The proposition to issue $4,000 in bonds, the proceeds to be used for the purchase of the local electric light plant, was defeated.

LINCOLN, KAN.—Sealed proposals will be received at the office of the city clerk, Lincoln, Kan., until May 25 for the reconstruction of the municipal electric lighting plant. General instructions for bidders, blank forms and other necessary information may be obtained at the office of P. F. Walker or George C. Shaad, Lawrence, Kan. J. W. Grubb is Mayor.

PARSONS, KAN.—The proposition to issue bonds for the construction of a municipal electric light plant is reported to be under consideration and will soon be submitted to a vote.

SEVERLY, KAN.—The proposition to issue $8,000 in bonds for the construction of an electric light plant will soon be submitted to the people. It is proposed to establish a plant to furnish electricity for lighting the streets of the village and for commercial and residential lighting. The street lighting system will consist of 60 lamps.

ATHOL, KY.—It is reported that the Breathitt Telephone Company, recently incorporated, is planning to erect a telephone system in Athol, and also extensions from Athol to Jackson and Elkawtaba, a distance of 25 miles, where long-distance connection will be made with Lexington.

CORNETTSVILLE, KY.—Plans are being prepared by the Cornettsville-Leatherwood Telephone Company, it is reported, for the erection of a local telephone system, with extensions to Hazard and Jackson, where long-distance connection will be made.

HINDMAN, KY.—The Hindman-Prestonburg Telephone Company, it is stated, contemplates making improvements and extensions to the local system, for which considerable new material will be required, including a new switchboard for the Hindman exchange.

HOMER, LA.—It is reported that E. G. Sawyer will rebuild the electric light plant, which was burned. It is said that generator has been ordered.

JENNINGS, LA.—The Jennings Electric Light & Power Company is contemplating the installation of an engine-driven alternating-current generator in its plant. The present generators are all of the direct-current type.

AUGUSTA, MAINE.—The United States Oil Company, recently incorporated, will erect and operate telephone lines in connection with its regular business. Lewis A. Burleigh and Ernest L. McLean, both of Augusta, Maine, are among the incorporators.

PORTLAND, MAINE.—The Continental Petroleum Company, recently incorporated, with a capital stock of $6,000,000, it is said, will erect and operate an extensive telephone system in connection with its other enterprises. Clarence E. Eaton is president of the company.

READFIELD, MAINE.—Option has been taken on the old woolen mill property in Readfield by Augusta capitalists. The property includes an excellent water power with steam auxiliary plant. It is understood that it is proposed to establish an electric light plant and water-works system for the purpose of furnishing electrical and water service in Readfield.

BOSTON, MASS.—Bids will be received at the office of the constructing quartermaster, 263 Summer Street, Boston, Mass., until June 3 for the construction of an electric lighting system at Fort Andrews, Mass. Plans, specifications and blank forms will be furnished on application to the above office. A deposit of $10 will be required to insure return of plans. Plans and specifications can also be seen at the office of the chief quartermaster, Department of the East, Governor's Island, N. Y. Captain A. M. Miller is constructing quartermaster.

MALDEN, MASS.—Beginning with July 1, 1910, the Malden Electric Company will reduce the price of electricity for lamps from 13 to 12 cents per kw-hour.

NORTH BROOKFIELD, MASS.—Frank E. Winchell, president of the Oxford Linen Mills, has applied to the Selectmen for a franchise to supply electricity in North Brookfield for lamps and motors. Eventually, if granted a franchise, he will light the streets of the town. It is proposed to form a stock company to install and operate the plant.

SALEM, MASS.—The Salem Electric Company has issued notices to all its customers using direct-current service that the service will be discontinued July 1. Owing to placing the wires underground it has been necessary to discard the direct-current service.

WORCESTER, MASS.—The Worcester Merchants' Association is considering the question of improving the illumination of Main and Front Streets.

WORCESTER, MASS.—Orders have been placed by the Worcester Consolidated Street Railway Company for a condenser for use in connection with engines of 5000 hp. George W. Dunlap is engineer of power stations.

DETROIT, MICH.—Application has been made to the Common Council by the Michigan United Railway Company for a 30-year franchise to enter the city and operate its railway from the westerly limits to the center of Detroit. The company wants to connect Detroit with its terminus at either Jackson or Lansing.

FLINT, MICH.—An effort is being made to interest Flint capital in the construction of an electric railway to Fenton and Long Lake, a distance of 16 miles. Under the present plans it is proposed to obtain the franchises held by Chester H. Bliss, of Flint. L. J. Weadock, of Toledo, Ohio, and J. Harry Kingsley, Jr., of Cleveland, Ohio, are interested in the project.

GRAND RAPIDS, MICH.—Edward P. Burch, consulting engineer, in his report submitted to the Water and Light Commission has recommended repairs to the water-works system, involving an expenditure of about $12,500 and include the installation of a 1250-gal. power pump and a steel tower and tank having a capacity of 150,000 gallons.

GRAND RAPIDS, MICH.—Edwin P. Burch, consulting engineer, who was engaged by the town to make investigations with a view of utilizing the water power of the Prairie River Falls, located about four miles north of the town, in connection with the municipal electric light plant, in his report has advised the village to secure water rights, which if developed would furnish a large amount of power, which could be furnished to private enterprises and also supply electricity for lamps, pumping and manufacturing purposes in all nearby towns. The cost of developing the Prairie River water power is estimated at about $100,000.

PONTIAC, MICH.—The Rapid Motor Vehicle Company is reported to be contemplating the installation of additional electric motors to operate its new machines.

AURORA, MINN.—Bonds to the amount of $10,000 have been voted, the proceeds to be used for the installation of a municipal electric light plant.

CALEDONIA, MINN.—It is reported that the village is planning to enlarge the municipal electric light plant.

DEERWOOD, MINN.—The Deerwood & Bay Lake Telephone Company has been granted a 20-year franchise in Deerwood, Minn.

RAYMOND, MINN.—Preparations are being made for the construction of a municipal electric light plant, including pumping station, in Raymond, during the coming summer, for which bonds were recently voted.

WATERTOWN, MINN.—The capital stock of the Watertown Telephone Company is reported to have been increased to $50,000.

GREENWOOD, MISS.—At a mass meeting held recently in the Village of North Greenwood the Village Council was authorized to receive bids for the installation of an electric lighting system, water works and sewerage system. Electricity for the lighting system will be secured from the municipal electric plant in Greenwood as at present.

MERIDIAN, MISS.—It is reported that Frank E. Smith, of Meridian, Miss., would like to receive estimates and information pertaining to the installation of an electric light plant to supply a city six miles square, having a population of from 30,000 to 35,000.

BAY ST. LOUIS, MO.—The Gulfport & Mississippi Coast Traction Company, of Gulfport, Miss., is reported to be contemplating extending its transmission lines to Bay St. Louis, to furnish electricity for lamps.

INDEPENDENCE, MO.—Burns & McDonnell, of Kansas City, Mo., consulting engineers, have submitted a report to the City Council recommending improvements to the municipal electric light plant, at a cost of about $44,410.

KIRKSVILLE, MO.—Plans are being considered for the construction of a large dam across the Charlton River at Kirksville, to furnish power to generate electricity, which will be used to operate the pumping station and to light the city. It is estimated that from 2000 to 5000 hp can be developed at a cost of from $75,000 to $100,000.

BAKER, MONT.—Hugh G. Twaddle, of Hecla, S. D., is reported to be contemplating the installation of an electric light plant in Baker, with sufficient output to supply 1000 lamps.

BUTTE, MONT.—I. A. Keilbronner and Charles F. Kelley are reported to be interested in a project to construct an electric railway to Anaconda, via Gregson Springs.

DILLON, MONT.—The capital stock of the Southern Montana Telephone & Telegraph Company has been increased from $10,000 to $40,000, the proceeds to be used for extensions and improvements.

FORT MISSOULA, MONT.—Sealed bids will be received at the office of the constructing quartermaster, Fort Missoula, Mont., until June 6, for the construction of a sewer system and water distributing system, including the erection of a 300,000-gal. steel tank and 100-ft. trestle, construction of a reinforced concrete pumping station, furnishing boilers, steam pumps, valves, etc. Alternate bids will be received for pumping station using motor driven pumps, including all motors, pumps, etc.; also for electricity for operating pumps and for other purposes. A deposit of $5 will be required for each set of plans and specifications. Further information will be furnished on application to Major A. B. Shattuck, constructing quartermaster.

LEWISTON, MONT.—Negotiations have been closed whereby S. W. Gebo is reported to have purchased the plant and holdings of the Citizens' Electric Company and the Spring Creek Power & Electric Company, both controlled by John L. Bright. Mr. Gebo also owns the Lewiston Coal, Light & Gas Company. The price paid for the plants is understood to be about $250,000. It is reported that Mr. Gebo is contemplating the construction of electric railways from this city, one of which will extend to Kendall. Both companies have been reorganized with David Hilger as president; S. W. Gebo, vice-president, and N. C. Carwile, secretary and treasurer.

BEATRICE, NEB.—The City Council has voted to call a special election May 31 to vote on the proposition to issue $70,000 in bonds, the proceeds to be used for the construction of a combined electric light and water plant.

BEATRICE, NEB.—Negotiations have been closed whereby Morris Freshman, of Beatrice, and H. A. Wheeler, of Omaha, Neb., have secured a site on the Blue River, five miles southeast of Omaha, where a concrete dam will be built. The water power is to be utilized to generate electricity.

CHANDRON, NEB.—The purchase of the local electric light system, owned by the Chandron Electric Light & Power Company, is reported to be under consideration by the city.

HAVELOCK, NEB.—Sealed proposals will be received by C. A. Currie, City Clerk, Havelock, Neb., until June 7, for the construction of extensions to the water works system, including two wells and suction line; station building, brick, 26 ft. x 30 ft.; reinforced concrete reservoir, of 125,000-gal. capacity; elevated steel tank and tower, of 75,000-gal. capacity; one triplex power pump, 300 gal. per minute, under 60-ft. head; one triplex power pump, 300 gal. per minute, under 300-ft. head; one two-stage or two single-stage centrifugal pumps, 700 gal. per minute, under 125-ft. and 250-ft. head; one 10-hp electric motor, one 75-hp electric motor, one 40-hp liquid fuel engine; also water mains, hydrants, valves, etc. The cost of the work is estimated at $42,552. Plans and specifications can be seen and proposal blanks obtained at the office of the city clerk or at the office of Grant & Letton, engineers, F & M Building, Lincoln, Neb. Extra copies of plans and specifications can be obtained from the engineers upon a payment of $7.50, of which $5 will be returned upon return of same.

LINCOLN, NEB.—The State Railway Commission has granted the Farmers' Telephone Company, of Dodge County, permission to increase its capital stock from $20,000 to $25,000, the proceeds to be used for extensions to its system.

LODGE POLE, NEB.—The Lodge Pole Telephone Company, recently organized, has received permission from the State Railway Commission to issue $20,000 in capital stock, the proceeds to be used for the construction of a telephone system.

OMAHA, NEB.—Sealed proposals will be received by Captain F. C. Bolles, Quartermaster, Omaha, Neb., until June 11 for the installation of two electric freight elevators in storehouse in the Omaha Depot. Further information furnished on application to the above office.

ATLANTIC CITY, N. J.—Plans are being prepared by E. D. Rightmire, city engineer, for the construction of an underground conduit from Gardner's Basin to the Beach thoroughfare.

ATLANTIC CITY, N. J.—The contract for installing generator, with exciter, switchboard and transformers, etc., at the Absecon pumping station has been awarded to the Fort Wayne Electric Company, Fort Wayne, Ind., for $4,056. L. Van Gilder is engineer and superintendent.

NEWARK, N. J.—The Public Building Commission has awarded the contract for the electrical work for the Tuberculosis Hospital at Soho to Storms & Company, of Newark, N. J., for $7,333. The contract for heating and electrical work at the County Hospital for the Insane at Overbrook, N. J., was also awarded to Storms & Company for $1,823 and $2,900, respectively. The Lord Electric Company, of New York, N. Y., secured the contract for installing the lighting system for yard at the County Hospital at Overbrook, N. J., for $21,224. Louis E. Voorhees is chairman of commission.

SOMERS POINT, N. J.—The Pleasantville Heat, Light & Power Company is reported to have secured a franchise in Somers Point to furnish electricity for lamps.

RATON, N. M.—Hugo Seaberg, of Raton, N. M., is reported to be in the market for a small electric plant to furnish electricity for an office block and hotel. It is proposed to install the plant in connection with a 50-hp low-pressure boiler now supplying steam heat to buildings.

BINGHAMTON, N. Y.—The City Council is considering the question of requiring all wires on Front Street between Webster Place and Clinton Street placed in underground conduits.

BUFFALO, N. Y.—It is reported that additional equipment will be installed in the power plant of the King Sewing Machine Company, in Buffalo, including an engine-driven generating unit with a rating of 200 kw and other apparatus.

GENEVA, N. Y.—The Economic Power & Construction Company and the Geneva-Seneca Electric Company have petitioned the Public Service Commission, Second District, for permission to the transfer of the franchises, works and system of the Economic Power & Construction Company, in the city of Geneva, to the Geneva-Seneca Electric Company. The application states that the proposed arrangement for the combination of the properties will result in a saving of operating expenses of $20,000 per year, including the steam heating plant. It is proposed to pay the Economic Company $103,000 for its property. Permission is also asked for authority to issue sufficient bonds to pay for same.

MIDDLETOWN, N. Y.—Work will soon commence on the construction of the addition to the power plant of the Orange County Lighting Company, contract for which was recently awarded to Barstow & Company, of New York, N. Y. The plans call for an addition to the engine room, 50 x 68 ft., to be built of brick, steel and concrete. The equipment will include a 640-hp, cross-compound, Corliss type engine made by Ball & Wood Company, direct connected to a 500-kw, General Electric generator; also switchboard and auxiliary equipment manufactured by the General Electric Company; two 350-hp Babcock & Wilcox engines; a motor-operated conveyor, made by the Jeffrey Manufacturing Company, and a 10-ton overhead traveling crane manufactured by the Niles Tool Company. The generating station on Monhagen Avenue, formerly the property of the Consumers' Light & Power Company, will be held in reserve for use in emergencies. In addition to the steam plants the company has available about 400 hp from the water power plant of the Orange County Power Company on the Neversink River, at Cuddebackville, N. Y.

NEW YORK, N. Y.—Judge Lacombe, of the United States Circuit Court, has authorized Frederick W. Whitridge, receiver of the Union Railway Company, to contract with the city for the construction of a double-track extension for that system, the extension to begin at the existing tracks at the intersection of Sedgwick Avenue and Fordham Road in the Bronx and run along Fordham Road and Hampden Place to West 184th Street and over the University Heights bridge to West 207th Street and to Amsterdam Avenue, thence through Emerson Street to Broadway, connecting there with the present system.

OVID, N. Y.—The Ovid Electric Company is reported to have decided to move its steam plant to Taughannock, a distance of three miles. The present system means practically operating two plants, and by consolidating the plants it is estimated thatt the service can be much improved and a considerable saving in the cost of operating effected.

PLATTSBURG, N. Y.—Sealed proposals will be received at the office of the constructing quartermaster, Plattsburg Barracks, N. Y., until June 9 for construction of one four-set officers' quarters at Plattsburg Barracks, including plumbing, heating and electric wiring and electrical fixtures. Plans and specifications may be seen at the above office and at the office of the chief quartermaster, Governor's Island, N. Y. A deposit of $10 will be required for plans and specifications to insure return of same. Captain Edward T. Hartman is constructing quartermaster.

TROY, N. Y.—The Columbia & Rensselaer Telephone & Telegraph Company has filed a certificate with the Secretary of State showing an increase in capital stock from $1,000 to $30,000.

CHARLOTTE, N. C.—The power plant of the Southern Power Company, of Charlotte, N. C., located at Ninety-nine Islands, on the Broad River, about four miles from Gaffney, S. C., has been placed in operation. The plant has an output of about 24,000 hp.

CLINTON, N. C.—The Sampson Power Company, recently incorporated with a capital stock of $10,000, has secured a site and will erect a power plant, with headquarters in Clinton. C. W. Petty, B. P. Smith and others are interested in the enterprise.

RALEIGH, N. C.—The contract for electric wiring the capitol building was awarded to the Carolina Electric Company for $2,275 and for heating and ventilating the building to Young & Hughes, of Raleigh, N. C., for $4,048.

SALISBURY, N. C.—It is reported that the properties of the Salisbury-Spencer Railway Company have been taken over by the Piedmont Railway Company. It is also stated that the Southern Power Company is behind the deal and proposes to utilize the lines as part of its proposed railway between Charlotte and Greensboro, a distance of 92 miles. W. F. Snider, T. H. Vanderford, T. J. Jerome and M. L. Jackson are interested in the Piedmont Company.

SILER CITY, N. C.—The construction of an electric light plant in Siler City is reported to be under consideration. A. J. Bean, of the Eagle Milling Company, is interested in the project.

FARGO, N. D.—We are informed that the awarding of the contract for the installation of an electric light and power plant at the North Dakota Agriculture College has been postponed indefinitely. W. A. Yoder is secretary.

MINOT, N. D.—The installation of a new electric light and power plant in Minot is under consideration. The cost of the plant is under consideration.

SCHAFER, N. D.—It is reported that the Hudson, Center & New Salem Electric Railway Company has secured a large portion of the right of way for its proposed electric railway, which is to extend from Center to Hettinger, Hudson and New Salem, a distance of 110 miles. Charles Whitmere has charge of the work.

AKRON, OHIO.—Plans have been prepared by the Osborn Engineering Company, of Cleveland, Ohio, for the construction of a new plant for the Firestone Tire & Rubber Company, bids for which will soon be received. The Firestone Company also proposes to build a new power plant, but as yet plans have not been prepared.

COLUMBUS, OHIO.—The contract for the installation of the power plant in the new Tuberculosis Hospital has been awarded by the County Commissioners to Erner-Hopkins Company, of Columbus, Ohio, for $5,465.

COLUMBUS, OHIO.—The North Side Chamber of Commerce has adopted a resolution asking the City Council to make use of the water power from the storage dam for operating the municipal electric light plant. The resolution states that much power is going to waste that might be utilized for this purpose.

COLUMBUS, OHIO.—Negotiations are under way by the Municipal Electric Lighting Department for the sale of electricity for industrial purposes to be furnished during the day. It is estimated that the plant can supply from 2500 to 3000 kw above that required by the city, and can be operated at a profit by the sale of 1500 kw during a 10-hour day.

DAYTON, OHIO.—The Board of Control has awarded the contract for street lighting to the Dayton Lighting Company for a term of 10 years. Under the terms of the contract the company is to furnish arc lamps at the rate of $66 per lamp per year, which will save the city $1,600 per year. At present the street lighting system consists of about 800 lamps.

MT. ZION, OHIO.—The Independent Telephone Company, recently organized, with a capital stock of $150,000, to take over the independent telephone lines in and about Macon County, has purchased the system owned by George D. Spitler, at Mt. Zion, for $30,000.

NORTH BALTIMORE, OHIO.—The question of establishing a municipal electric light plant is under consideration. It is expected that the proposition to issue $20,000 in bonds, the proceeds to be used to establish such a plant, will be submitted to a vote at a special election to be held about the middle of June.

WILLOUGHBY, OHIO.—After several years' trial the Town of Willoughby has decided to abandon its municipal electric light plant and has granted the Cleveland, Painesville & Eastern Traction Company a 10-year franchise and a contract for street lighting. The plant was closed down three months ago, and since then the streets have been in darkness. The traction company is installing transformers and as soon as the work is completed elctricity will be furnished for both street and residential lighting. It is estimated that the town has lost more than $75,000 through its municipal ownership experiment.

GUYMON, OKLA.—The City Council is considering the question of calling an election to vote on the proposition to issue bonds for the purchase of the electric light plant.

MEDFORD, OKLA.—Contract has been awarded by the City of Medford, Okla., to the H. N. Strait Manufacturing Company, of Kansas City, for two Monarch Corliss engines with a combined rating of 225 hp. The smaller engine will be direct-connected to a new 50-kw generator. Bids for a 100-kw alternating-current generator, also two return tubular boilers, feed pumps, heater, etc., were rejected, and contracts will not be closed until May 26.

STONEWALL, OKLA.—It is reported that Oklahoma City and Ada capitalists are interested in the development of a large water power, located near Stonewall, Okla., about 16 miles from Ada. It is proposed to utilize electricity generated at the plant for operating an interurban railway and for lighting purposes. Dr. J. J. McKenna, Dell McKenna, of Oklahoma City, Okla.; J. E. Smith, M. L. Wall and A. H. Constant, of Ada, Okla., are interested in the project.

HILLSBORO, ORE.—E. W. Haines is contemplating the construction of an electric lighting system in Hillsboro.

KLAMATH FALLS, ORE.—The proposition to establish a municipal lighting plant in Klamath Falls is under consideration.

LA GRANDE, ORE.—The Eastern Oregon Light & Power Company is reported to be contemplating extending its transmission lines and service to Elgin, a distance of 20 miles. The company will also furnish electrical service to towns and villages along the route of the line.

MEDFORD, ORE.—Preparations are being made by the Rogue River Water & Power Company for extensive extensions and improvements to its property, which will involve an expenditure of about $100,000. The plans call for the construction of a power plant on the Gold Hill Canal, for which surveys have already been made.

BEAVER, PA.—Plans have been submitted to the Borough Council by Mr. Martin, electrical engineer, for the construction of a municipal electric light plant. Two separate estimates were submitted, one calling for an expenditure of $49,200 and the other for $56,400. The first plan submitted showed operating expenses of $9,470 and earning capacity of $11,932, and the second the cost of operating at $10,605 and an earning capacity of $13,825. The report was referred to the light committee and the ordinance committee.

JOHNSTOWN, PA.—The Citizens' Light, Heat & Power Company is contemplating extending its transmission lines to Geistown and surrounding territory.

PHILADELPHIA, PA.—The Philadelphia Electric Company is reported to be planning to build a power plant on Ranstead Street.

PHILADELPHIA, PA.—Plans are being considered by the Philadelphia & Western Railway Company for extending its railway from Stafford through Lower Merion and Upper Merion, via Gulf Mills, to the western shore of the Schuylkill River in Bridgeport, there crossing the river to Norristown and thence the townships of East Norriton, Whitpain and Upper Gwynedd, connecting with the Lehigh Valley Transit system at or near North Wales.

PITTSBURGH, PA.—The stockholders of the West Penn Railway Company have voted to increase the bonded indebtedness of the company from $6,000,000 to $12,000,000. The proceeds will be used for improvements and extensions, which will be issued from time to time as extensions are made.

READING, PA.—The Textile Machine Works, of Reading, is reported to be constructing a new power plant with an output of about 1000 hp, the equipment of which will include a Fort Wayne generator direct-connected to a Nordberg cross compound engine. It is understood that contracts for machinery have been placed.

WOODVILLE, PA.—The contract for construction of power house for the Allegheny County Home, at Woodville, Pa., has been awarded to the Dawson Construction Company, of Pittsburgh, Pa., for $21,765.

EASLEY, S. C.—Walton & Wagner, of Atlanta, Ga., consulting engineers, are reported to have been engaged by the City Council to take charge of the construction of the municipal electric light plant and water works system, for which $30,000 in bonds were recently voted.

GREENVILLE, S. C.—The Gilreath Manufacturing Company, recently incorporated with a capital stock of $50,000, is planning to establish a plant in Williams Hall for the manufacture of cotton underwear, etc. The mill will be equipped for electrical operation. J. D. Gilreath, J. M. Geer and others are interested in the project.

GREER, S. C.—The city has decided to install an arc lamp street lighting system, bids for which have been received. It is understood that the Southern Power Company, of Charlotte, N. C., will furnish electricity for operating the system.

SPEARFISH, S. D.—The Redwater Valley Telephone Company is reported to be contemplating the erection of a telephone line to Deadwood and Lead.

ARLINGTON, TENN.—It is reported that the city of Arlington is contemplating the construction of light and ice plant and water works system.

BRISTOL, TENN.—The plant and holdings of the Bristol Gas & Electric Company are reported to have been purchased by Henry L. Doherty & Company, of New York, N. Y. It is understood that Mr. Doherty will be president of the new company.

MEMPHIS, TENN.—Preparations are being made by the Lake View Traction Company for the construction of a power house on the section of its system extending from Memphis to Lake View. The equipment will include three 200 or 250-hp Heine water tube boilers and two 200-kw, 550-volt, direct-current generators for railway service, and one 200-kw, alternating current, 60-cycle, 2300-volt, single-phase generator for furnishing electricity for lamps. The company proposes to construct an electric railway, 160 miles in length, to connect Memphis and Clarksdale, and expects to have the section from Memphis to Lake View, a distance of 11 miles, completed by July 1. The overhead trolley system will be used.

BELTON, TEX.—George C. Pendleton is reported to have purchased the local electric light plant for $32,500.

DALHART, TEX.—The Canadian Telephone Company has been granted a franchise to construct telephone lines, exchange and fire alarm system in Dalhart. The central battery system will be installed. D. O. Hazleton and Allen Spain, of Rector, Ark., are interested in the company.

GEORGETOWN, TEX.—Plans have been prepared by the Georgetown Telephone Company for the construction of a new telephone exchange in Georgetown, at a cost of about $6,000.

LANCASTER, TEX.—The Lancaster Milling Company is reported to be contemplating the installation of an electric plant to furnish electricity for lamps and motors during the coming summer.

TERRELL, TEX.—At an election to be held May 27, the proposition to issue $8,000 in bonds, the proceeds to be used for extensions and improvements to the electric light plant and water works system, will be submitted to a vote.

IDAHO FALLS, UTAH.—George H. Lawrence has financed his proposed electric railway from Idaho Falls and Hizer's Hot Springs. Rights of way have been secured and work on construction of the railway will begin July 1.

MILFORD, UTAH.—The Beaver Irrigation & Power Company is planning for the irrigation and development of 76,000 acres of land in Beaver County, which will involve an expenditure of about $1,000,000. The company has been financed by B. F. Walling & Company, of Chicago, Ill., who have opened offices in the Felt Building, Salt Lake City, Utah. A. B. Lewis is president of the Beaver Irrigation & Power Company.

SALT LAKE CITY, UTAH.—The Utah Railway, Light & Power Company is making extensive additions and improvements to the Jordan River power station. The new equipment will include a 1000-kw steam turbine, which will be used as an auxiliary and in case of emergencies.

BRISTOL, VA.—Mayor Rice has vetoed a contract made by the City Council with Theodore Swann, representing a new company, for lighting the city for a term of 10 years. The Mayor held that the Council did not act within the law, having failed to advertise 30 days for competitive bids.

RICHMOND, VA.—The Richmond & Henrico Railway Company is reported to have secured an option on a site at the foot of Louisiana Street for its proposed power plant, plans for which are being prepared by E. W. Trafford, of Richmond, Va., consulting engineer.

RICHMOND, VA.—The Southern Plumbing & Electric Company, which held contracts for certain of the interior fittings of the new municipal electric light plant, amounting to about $12,000, has gone into bankruptcy, and has surrendered its contract, no part of which has been executed. The Council committee on electricity has authorized E. W. Trafford, consulting engineer, to advertise at once for new bids on that part of the work.

HUSAM, WASH.—It is reported that an option has been secured of R. D. Cameron by the Demont Brothers Milling Company, of Walla Walla, for land on both sides of the White Salmon River for the purpose of constructing a large concrete dam and an electric power plant, work on which will commence immediately. Work will also commence at once on construction of the company's flour mills in Underwood.

ODESSA, WASH.—The Washington Power Company, it is reported, will commence work at once on the construction of a 21-mile transmission line to furnish electricity in Odessa.

PE ELL, WASH.—L. A. Webb and associates are interested in the construction of an electric light plant in Pe Ell. Contract for construction of the plant has already been awarded. The cost of the plant is estimated at about $25,000. L. A. Webb is general manager.

SEATTLE, WASH.—Permission has been granted to the Seattle Electric Company to equip the Madison cable line for electrical operation from Twentieth Avenue to Madison Park.

SPOKANE, WASH.—The Washington Water Power Company is contemplating extending its Cannon Hill transmission line through Cannon Hill Park, Irving Heights, Clifton Highlands, Jerome Park and Highlands additions to Twenty-ninth Avenue and Howard Street. Work will commence on the proposed extensions as soon as the franchise is secured.

CRIVITZ, WIS.—The Crivitz Pulp & Paper Company, of Crivitz, Wis., is said to be considering the question of constructing a hydroelectric power plant, to be equipped with low-head impulse turbines and direct-connected generators during the coming summer.

EAU CLAIRE, WIS.—It is reported that the Lindermann Box & Veneer Company, of Eau Claire, Wis., is contemplating rebuilding its plant, recently burned. It is understood that a larger plant will be erected and will be equipped for electric motor drive.

GREEN BAY, WIS.—It is reported that contracts for electrical equipment for the new building of the Northern Paper Mills will soon be awarded.

LA CROSSE, WIS.—It is reported that another election will be held to vote on the proposition to issue $50,000 in bonds for the construction of a municipal electric light plant.

ONTARIO, WIS.—A company is being organized under the name of the Ontario Railway Company for the purpose of constructing a railway from Ontario to Wilton or Norwalk, over a route recently surveyed. C. Lord, of Ontario, Wis., is interested in the project.

SPARTA, WIS.—The City of Sparta is contemplating the installation of a new pumping plant, having a capacity of 1,500,000 gal., to replace the present 40-hp outfit. Investigations are being made in regard to equipment of same, including new boilers, pumps and also gas-producer plants. For further information address H. Teasdale, president of Water Commission.

SUPERIOR, WIS.—The directors of the Superior Water, Light & Power Company have authorized the extension of the water, light and gas service, which will involve an expenditure of about $60,000. This amount will be about evenly divided between the three departments.

CHEYENNE, WYO.—Bids will be received until May 23 at the office of the constructing quartermaster, Cheyenne, Wyo., for construction, plumbing, wiring for electric motors and lamps, electric fixtures, furnishing and installing laundry machinery and equipment, boiler, feed pump, etc., for one laundry, according to plans No. 234-B, Fort D. A. Russell, Wyo. Plans and specifications can be seen in the above office, also in the offices of the chief quartermaster, Department of the Lakes, Chicago, Ill.; chief quartermaster of the Missouri, Omaha, Neb.; chief quartermaster, Department of the Colorado, Denver, Col., and the secretary of the Builders' Exchange, St. Paul, Minn. Proposal blanks and general instructions may be obtained at the above-named office. Captain V. K. Hart is acting quartermaster.

MINNEDOSA, MAN., CAN.—Preparations are being made by the Town of Minnedosa for the construction of a municipal electric light plant, bids for which will soon be called. The plant will be located on the Little Saskatchewan River within the town. The first installation will provide for 50 hp. The equipment will include a 450-hp generator and an exciter unit of 50 hp. For further information address the Mayor.

TORONTO, ONT., CAN.—Bids will be received until May 23 by Darling & Pearson, 2 Leader Lane, Toronto, Ont., Can., for furnishing and installing all heating and electrical apparatus, constructing tunnels

etc., for the central light, heat and power plant for the University of Toronto. Plans and specifications for the entire work can be seen at the office of the architects.

ESTAVAN, SASK., CAN.—A by-law authorizing an expenditure of $25,000 for the construction of a municipal electric light plant has been voted by the ratepayers.

LLOYDMINSTER, SASK., CAN.—The by-law passed by the City Council granting an eight-year franchise to W. Johnson to operate an electric light plant in Lloydminster has been ratified by the ratepayers.

New Industrial Companies.

THE AMERICAN CAR EQUIPMENT COMPANY, of Chicago, Ill., has filed articles of incorporation with a capital stock of $100,000. The company proposes to manufacture railway equipment and rolling stock. The incorporators are: J. B. Wescott, I. M. Berner and M. L. Rosenbom.

THE AUTOPHONE COMPANY, of Stockton, N. J., has been incorporated with a capital stock of $40,000 by T. S. Moore, J. W. Smith and A. B. Hockenbury, all of Stockton, N. J. The company proposes to deal in patents, etc.

THE AUTOMATIC GRAVITY BOILER FEEDER COMPANY has filed articles of incorporation with a capital stock of $100,000. The incorporators are: G. Corbion, M. Van Booskirk, of Philadelphia, Pa., and A. P. Stevenson, of Wilmington, Del.

THE AUTOMATIC SPRINKLER COMPANY OF AMERICA, of Trenton, N. J., has been chartered with a capital stock of $2,000,000 for the purpose of manufacturing devices, machinery, etc. The incorporators are: William H. Randel and Peter B. Olney, Jr., both of 68 William Street, New York, N. Y., and Edwin Vandewater, of Jersey City, N. J.

BILLMYER & FALK, of Portland, Maine, have filed articles of incorporation with a capital stock of $10,000, for the purpose of dealing in electrical supplies. The officers are: Mervy J. Falk, of New York, N. Y., president; John J. Myer, of Boston, Mass., treasurer, and W. J. Knowlton, of Portland, Maine, clerk.

THE BLIGHTON-CLANCY MANUFACTURING COMPANY, of Olean, N. Y., has been incorporated by E. C. Blighton, H. J. Blighton and E. J. Clancy, of Olean, N. Y. The company is capitalized at $25,000 and proposes to manufacture and sell patented articles and improvements, etc.

THE BRYSON CONTRACTING COMPANY, of New York, N. Y., has been incorporated by Thomas B. Bryson, John H. Thomas and Charles W. McCandless, all of New York, N. Y. The company is capitalized at $5,000 and proposes to do engineering work of all kinds and excavating foundation work.

THE CLARK MOTOR COMPANY, of Buffalo, N. Y., has been incorporated with a capital stock of $50,000 for the purpose of manufacturing automobiles, motors, engines, etc. The incorporators are: S. B. DeLong, J. W. Van Allen and H. J. Rante, of Buffalo, N. Y.

THE E. C. BRADLEY COMPANY, of Rochester, N. Y., has been incorporated by Anna M. Bradley, Edward C. Bradley and William J. Bradley, all of 17 Stone Street, Rochester, N. Y. The company is capitalized at $5,000 and proposes to do a general electrical hardware business.

THE ECLIPSE ELECTRICAL COMPANY, of Lincoln, Neb., has been incorporated with a capital stock of $10,000 by George L. Reeder, George W. Dunkle, John J. Davis, Emmor W. Tatum and Doyce Lower.

THE ELECTRICAL CONSTRUCTION COMPANY, of Holyoke, Mass., has been incorporated with a capital stock of $5,000. The directors are: Raymond P. Hill, of Holyoke, Mass., president and treasurer; H. A. Strong and W. H. Crosby.

THE ESSEX STORAGE BATTERY & SUPPLY COMPANY, of Newark, N. J., has been chartered with a capital stock of $25,000 by Lazarus Simon, Harry H. Lipkowitz and James J. McMannus, all of Newark, N. J. The company proposes to manufacture electric motors, dynamos, etc.

THE FEDERAL SIGN SYSTEM, of Oklahoma City, Okla., has been chartered with a capital stock of $10,000 by H. A. Stewart, J. W. Lindsey and Ross N. Lillard. The company proposes to manufacture electrical signs.

F. V. SMITH & SON, INC., of New York, N. Y., has been chartered with a capital stock of $5,000 to do general contracting business of all kinds. The incorporators are: F. Vinton Smith, Eighty-sixth Street and Broadway, New York, N. Y.; John J. Donnocan and Edmund J. O'Connor, both of New York, N. Y.

THE HARPER ENGINEERING COMPANY, of New York, N. Y., has been chartered by E. F. Berkeley, of New York, N. Y.; W. Harper, Jr., and A. J. Clayton, both of Brooklyn, N. Y. The company is capitalized at $50,000 to manufacture and deal in engines, automobiles, motor boats, etc.

THE HARTMAN CIRCUIT BREAKER COMPANY, of Mansfield, Ohio, has been incorporated with a capital stock of $10,000 by William Bowers, E. R. Hartman, J. E. Upson, I. R. Umbargo and Edward Aheim.

THE INTERNATIONAL AUTOMATIC RAILWAY SWITCH COMPANY, of Birmingham, Ala., has been organized with a capital stock of $10,000 by W. W. Coghill, George A. Neal and Baxter Shemwell.

THE MACARTHUR-EDDY COMPANY, of New York, N. Y., has been chartered with a capital stock of $500,000 by J. R. Macarthur, C. B. Edy and L. Fox, of New York, N. Y. The company proposes to do a general construction business, building railways, bridges, reservoirs, tunnels, etc.

THE MODERN TRANSMISSION MECHANISM ENGINE COMPANY, of New York, N. Y., has been chartered by G. R. Jaeger, F. W. Jaeger and F. Eveland, of New York, N. Y. The company is capitalized at $25,000 and proposes to manufacture and deal in motors, engines, pumps, etc.

THE NATIONAL ELECTRIC ASSOCIATION, of Boston, Mass., has been incorporated with a capital stock of $50,000 for the purpose of establishing a school for instruction in electrical and mechanical branches. W. B. Clayton is president and J. W. Craig treasurer, both of Boston, Mass.

THE NATIONAL ELECTRIC STEEL COMPANY, of Camden, N. J., has filed articles of incorporation with a capital stock of $2,500,000, for the purpose of dealing in iron and iron ores, etc. The incorporators are: F. R. Hansall, G. H. B. Martin and S. C. Seymour, of Camden, N. J.

THE NATIONAL INDICATOR COMPANY, of Newark, N. J., has been chartered by J. S. Bizel, G. H. Lenney, L. A. Meyer, C. H. Lane and E. B. Webb, of Bound Brook, N. J. The company is capitalized at $500,000 and proposes to manufacture devices for the purpose of indicating upon cars, railroads and trains, station names or numbers, etc.

THE PENINSULAR ENGINEERING COMPANY, of Chattanooga, Tenn., has been organized with a capital stock of $15,000 by Lewis M. Coleman, W. M. Johnson, W. L. Frierson and others.

THE PITTSBURG PORTABLE ELECTRIC DRILL COMPANY, of Camden, N. J., has been incorporated by J. A. MacPeak, G. A. B. Martin and I. C. Clow, of Camden, N. J. The company is capitalized at $200,000 and proposes to do a mechanical and electrical engineering business, machinists, etc.

THE SAFETY ELECTRIC COMPANY, of Newark, N. J., has been incorporated by Charles P. Taylor, Charles H. Fay and Scott German, all of Newark, N. J. The company is capitalized at $125,000 and proposes to manufacture electric motors, dynamos and other electrical machinery.

THE SAYLOR-GENERATOR GRATE & STOKER COMPANY, of Boston, Mass., has filed articles of incorporation, with a capital stock of $100,000 for the purpose of manufacturing and selling furnaces, boilers, etc. F. C. Saylor is president, and C. W. Adams, of Quincy, Mass., treasurer.

THE SCHERL MONORAIL COMPANY, of Jersey City, N. J., has been chartered with a capital stock of $125,000 by John W. Hertzler, 38 Park Row, New York, N. Y., and Thomas A. Renwick, of Greenville, N. J. The company proposes to manufacture monorail cars and automobiles, etc.

THE SOUTH ATLANTIC CONTRACTING & CONSTRUCTION COMPANY, of Atlanta, Ga., has been incorporated with a capital stock of $15,000 by Maurice W. Thomas, H. N. Randolph and Hugh M. Scott.

THE STARR-PATTERSON ENGINEERING COMPANY, of New York, N. Y., has filed articles of incorporation with a capital stock of $10,000 for the purpose of doing surveying and engineering work of all kinds. The incorporators are: Oliver F. Starr, of Mt. Vernon, N. Y.; Ross E. Patterson, 324 West Ninety-sixth Street, New York, N. Y., and Charles B. Ford, of Brooklyn, N. Y.

THE STEVEN CONSTRUCTION COMPANY, of Chicago, Ill., has been incorporated with a capital stock of $25,000 by A. F. Stern, R. B. Steven and M. J. Glone, all of Chicago, Ill. The company is capitalized at $25,000, and proposes to do a general contracting and construction business.

THE TUNGSTEN LAMP REPAIR COMPANY, of East Orange, N. J., has been incorporated with a capital stock of $50,000 to manufacture electric motors, dynamos, batteries, etc., by H. E. Verpolliere, C. O. Geyar and F. E. Ruggles, all of East Orange, N. J.

THE WHITE SPOT SAFETY SIGNAL COMPANY, of New York, N. Y., has been incorporated with a capital stock of $100,000 by J. O'Brien, E. E. Davis, of Montclair, N. J., and J. T. Blunt, of New York, N. Y. The company proposes to manufacture and deal in automatic signals for automobiles, carriages and vehicles of all kinds.

THE WINANS MACHINE COMPANY, of Binghamton, N. Y., has been chartered with a capital stock of $75,000 by Thomas J. Winans, Daniel M. Winans and Charles J. Knapp, all of Binghamton, N. Y. The company proposes to manufacture and deal in machinery, tools, etc.

THE W. W. ELECTRIC SIGN COMPANY, of Oklahoma City, Okla., has been incorporated with a capital stock of $25,000 by L. E. Knight, F. J. Wilcox and A. A. Weigle.

New Incorporations.

BIRMINGHAM, ALA.—Articles of incorporation have been filed for the Dauphin Island Railway & Harbor Company, with a capital stock of $3,000 for the purpose of constructing an interurban railway from Gadsden to Tuscaloosa, via Birmingham, to be extended by water or

otherwise to Dauphin Island. The officers are: George T. Bishop, of Cleveland, O, president and treasurer; F. F. Graves, of Chicago, Ill., vice president, and J. M. Dewberry, of Birmingham, Ala., secretary.

GADSDEN, ALA.—The Noccalula Railway, Light & Power Company has applied for a charter to construct an electric railway from Gadsden to the Falls in Black Creek, on Lookout Mountain. The capital stock of the company is placed at $300,000. H. A. Rogers is interested in the project.

SCRANTON, ARK.—The Scranton Telephone Company has been chartered with a capital stock of $4,000 by R. B. Chitwood, J. D. Baker and C. E. Hays.

SAN FRANCISCO, CAL.—The Thomas Gas, Light & Power Company has been incorporated, with a capital stock of $50,000, for furnishing illumination in San Francisco. The incorporators are: R. Thomas, L. O. Schmalle, J. Weirich and W. W. Haselhurst.

SAN FRANCISCO, CAL.—The South Side Light & Power Company has been incorporated, with a capital stock of $1,000,000, for the purpose of furnishing electricity in San Francisco. The incorporators are: Carroll N. Beal, James Fisher, E. R. Hough, T. R. Sullivan and Frederick G. Cartwright. The offices of the company are located in the Humboldt Bank Building, San Francisco, Cal.

SAN FRANCISCO, CAL.—Articles of incorporation have been filed for the United Light & Power Company, with a capital stock of $6,000,000. The directors are: Alfred Sutro, of San Francisco, Cal.; William T. Barnett, of Berkeley, Cal.; Edgar T. Zook, of San Rafael, Cal., and Charles C. Sullivan, of Verano, Cal. The company proposes to generate and distribute electricity and gas for public consumption.

DOVER, DEL.—Articles of incorporation have been filed with the Secretary of State by the Kermont Lighting Company, with a capital stock of $25,000. The incorporators are: C. Douch, of Philadelphia, Pa.; W. H. Dare, of Harrisburg, Pa., and E. E. McWhiney, of Philadelphia, Pa.

DOVER, DEL.—The Mississippi River Power Company has filed articles of incorporation with a capital stock of $3,000,000. The incorporators are: John J. Loughlin, of Brooklyn, N. Y.; J. F. Carroll, New York, N. Y., and Harry W. Davis, of Wilmington, Del.

CALDWELL, IDAHO.—Articles of incorporation have been filed for the Caldwell-Roswell Interurban Railway Company by H. W. Dorman and others. The company is capitalized at $250,000 and proposes to construct an electric railway between Caldwell and Roswell.

DECATUR, ILL.—The Macon County Telephone Company has been incorporated with a capital stock of $150,000 by J. W. Collins, W. E. Surface and A. V. Brownback.

FREEPORT, ILL.—Articles of incorporation have been filed for the Freeport Telephone Exchange Company by Roy K. Farrell, Fred M. Gund and R. R. Tiffany. The company is capitalized at $50,000 and proposes to do a general electric and telephone business.

MARION, ILL.—The Marion Railroad Company has been incorporated by A. E. Harper, William D. Hayne, E. J. Hughes, L. D. Doty and C. A. Brickett, of Chicago, Ill. The company proposes to construct and operate an electric railway from Marion to Johnson City.

BEDFORD, IND.—Articles of incorporation have been filed for the White River Power Company, with a capital stock of $10,000, for the purpose of constructing and operating a hydroelectric power plant to transmit electricity for lamps and motors. It is understood that the plant will be erected on the White River, near Bedford. The incorporators are: Milton Myer, Albert F. Fountain and John F. Freeland.

BRAZIL, IND.—The Jackson Township Telephone Company has been chartered with a capital stock of $10,000 by John Hoffman, Willis McCullough, George Youngblood, Charles W. Evans and Ralph Risler.

STAUNTON, IND.—The Staunton Telephone Company has been chartered with a capital stock of $1,500 by L. Weaver, John Haladefer and Joseph T. Feiful. The company proposes to construct and operate telephone exchanges and lines throughout Clay and adjacent counties.

SULLIVAN, IND.—The Sullivan County Electric Company has been incorporated by Henry C. Dies, M. E. Nebeker and C. M. Poor. The company is capitalized at $60,000 and proposes to construct and operate an electric plant to furnish electricity for lamps, heat and motors in the towns of Sullivan, Shelburn, Farmersburg and other villages along the transmission lines of the company.

GUNDER, IA.—The Marion Telephone Company has been incorporated with a capital stock of $4,000 by H. H. Gilbertson, N. T. Loftsgaard, E. E. Landsgard, T. H. Olsen, A. S. Haug and K. A. Kirkeberg.

GLASGOW, KY.—Articles of incorporation have been filed for the New Home Telephone Company, with a capital stock of $40,000, by W. R. Gardner, W. F. Pardue, T. P. Dickinson, and others.

OWENSBORO, KY.—The Owensboro Telephone & Telegraph Company has been incorporated with a capital stock of $10,000 by Joshua D. Powers and Samuel M. Heller. The company is a reorganization of the Kentucky and Indiana Telephone Company.

HARMONY, MAINE.—The Harmony & Wellington Telephone Company has been incorporated with a capital stock of $5,000. The officers are: A. H. Willis, president; S. W. Hervich, treasurer, and W. McLaughlin, clerk.

CLAYTON, MO.—The St. Louis County Telephone Company has filed articles of incorporation with a capital stock of $20,000. The office of the company will be located at the White House, 15 miles from St. Louis, Mo. The directors are: J. Arthur Christopher, secretary and treasurer; Henry Kortjohn and Edgar R. Simpson.

LONE JACK, MO.—A charter has been granted to the White Oak Telephone Company, with a capital stock of $4,500. The directors are: James D. Jackson, Fred L. Perdue, John W. Season, James D. Kreger and Henry C. Cave.

ST. LOUIS, MO.—The Abilene Independent Telephone & Telegraph Company has been chartered, with a capital stock of $300,000, by Stanley A. Jones, of Chicago, Ill.; Xenophen Wilfley, Richard T. Shelton, William T. Nardin and Henry L. Sittel, all of St. Louis, Mo.

MILES CITY, MONT.—The Miles City Automatic Telephone Company has been incorporated with a capital stock of $300,000 by H. H. Hanson and others.

SALTESE, MONT.—Articles of incorporation have been filed for the Saltese Electric Light & Water Company, with a capital stock of $10,000, by H. E. Rogers and others.

THOMPSON FALLS, MONT.—Articles of incorporation have been filed for the Thompson Falls Light & Power Company by Edward Donlan and others. The company is capitalized at $30,000 and proposes to develop water power from Prospect Creek.

LONG PINE, NEB.—The Long Pine & Southern Telephone Company has been incorporated with a capital stock of $10,000 by B. F. Buell, H. B. Simpson, and others.

ATLANTIC CITY,, N. J.—The Interurban Telegraph News Company has been chartered with a capital stock of $1,000,000 by Richard H. Robertson, Russell L. Bowne and Coleman H. Watkins. The company proposes to distribute news over leased wires of operating telephone and telegraph companies.

STOCKTON, N. J.—The Autophone Company, of Stockton, has filed articles of incorporation, with a capital stock of $40,000, for the purpose of conducting a telephone business. The incorporators are: Theodore S. Moore, John W. Smith, Asa B. Hockenbury, Thomas Slater and others, of Stockton, N. J.; George Rogers and Renton M. Hildebrand, of Centre Bridge, N. J.

ARCHERS' FORK, N. Y.—The Corby-Cady Telephone Company has been chartered with a capital stock of $10,000 by John Taylor and others.

GREAT VALLEY, N. Y.—Articles of incorporation have been filed for the Great Valley Telephone Company, with a capital stock of $3,000 by W. H. Folts, of Kilbuck, N. Y.; C. F. Hess, of Great Valley, N. Y., and M. Berger, of Salamanca, N. Y.

NEW YORK, N. Y.—The Third Avenue Railway Company has been incorporated with a capital stock of $16,590,000 by interests which purchased the property of the Third Avenue Railroad Company on March 1. The directors are: James N. Wallace, Adrian Iselin, Harry Bronner, James Timpson, Frederick H. Shipman, W. Emlen Roosevelt, Albert W. Scholle, Joseph H. Seaman, Edward A. Maher, Franklin L. Babcock, Milton Ferguson, John W. Platten, of New York, N. Y., and George W. Davidson, of Brooklyn, N. Y.

NEW YORK, N. Y.—The Southern New York Power Company has been incorporated with a capital stock of $50,000 by Albert H. Sewell, of Walton, N. Y.; Roy C. Megarel, of New York, N. Y., and Carleton A. Graves, of Brooklyn, N. Y.

PORT DICKINSON, N. Y.—Articles of incorporation have been filed for the Port Dickinson & Fenton Independent Telephone Company by W. T. Haney, Theodore M. Macomber, Floyd O. Hotchkiss, all of Port Dickinson, N. Y. The company is capitalized at $5,000.

PORT RICHMOND, N. Y.—Articles of incorporation have been filed for the Staten Island & Bayonne Subway & Development Company, for the purpose of laying out a rapid transit route from Port Richmond to Tottenville. The company is capitalized at $10,000. The directors are: Charles E. Griffith, Edward P. Doyle, William Van Clief and Frank Foggin, of Port Richmond, N. Y.

BUFFALO CITY, N. C.—The East Lake Telephone Company has been organized with a capital stock of $10,000 by D. M. Stringfield, I. J. Edwards and J. W. Twiford.

HUNTERSVILLE, N. C.—The Huntersville Telephone Company has been incorporated with a capital stock of $100,000 by S. L. Mullan, J. M. Bigham and others.

CALIO, N. D.—The Trier Rural Telephone Company has been chartered with a capital stock of $15,000 by J. P. Dunigan, of Munich, N. D.; Peter Schuler, August Korb, of Calio, N. D., and others.

CARRINGTON, N. D.—Articles of incorporation have been filed for the Haven Telephone Company, with a capital stock of $15,000, by P. C. Peterson, Albert Rosenau, and R. S. McIntyre, all of Carrington, N. D.

MOHALL, N. D.—The Mohall Telephone Company has been chartered with a capital stock of $50,000 by R. H. Williamson, M. H. Williamson and N. Iverson, all of Mohall, N. D.

MYLO, N. D.—Articles of incorporation have been filed for the Mylo Farmers' Telephone Company, with a capital stock of $5,000, by C. A. Mange and J. G. Mundy.

SHERWOOD, N. D.—The Barber Mutual Telephone Company has been incorporated with a capital stock of $15,000 by M. J. Burns, John K. Kuger, O. R. Walker, of Sherwood, and others.

HUDSON, OHIO.—Articles of incorporation have been filed for the Hudson Telephone Company by Clifford A. Neff, W. S. Lester, William C. Rhodes, P. A. White and M. D. Meisel. The company is capitalized at $30,000 and proposes to construct an independent telephone line in Hudson.

TIPPECANOE CITY, OHIO.—The Tippecanoe Telephone Company has been chartered with a capital stock of $70,000 by Samuel R. Fergus, Ellis H. Kerr, Charles O. Davis, Charles E. Emerick and A. H. Garver.

MUSKOGEE, OKLA.—Articles of incorporation have been filed for the Muskogee Transit Company by E. W. Mangson, Oliver Borwick, of St. Louis, Mo.; O. D. Revelle, of Asheville, N. C.; T. Bixby, Charles Bliss, Thomas Smith, M. F. Hancock and George A. Murphy, of Muskogee, Okla. The company is capitalized at $100,000, and proposes to construct an electric railway from Muskogee to Wagoner.

EUGENE, ORE.—The Eugene Heating & Electric Power Company has been incorporated with a capital stock of $15,000 by J. D. Natlock, E. Bangs and S. H. Friendly. The company proposes to install a heating plant in this city.

TOLEDO, ORE.—The Lincoln County Telephone & Telegraph Company has been incorporated with a capital stock of $10,000 by W. K. Merrill, F. K. Patton and R. B. Walls.

CONNELLSVILLE, PA.—The Wells-Mills Electric Company has been chartered with a capital stock of $6,000. The directors are: G. W. Wells, Thomas Mills and J. N. Ruth, all of Connellsville, Pa.; J. N. Ruth is treasurer.

ELIZABETH, PA.—The Elizabeth Rural Telephone Company has been incorporated, with a capital stock of $6,000, by James Christy, J. W. McKinney, W. P. Caldwell, Frank Hayden, D. P. Dougless and others, of Elizabeth, Pa.

HOOVERSVILLE, PA.—The Hooversville Light, Heat & Power Company has been chartered with a capital stock of $12,000 by Calom Fulton, of Stoyestown, C. W. Weigle, and John J. Bowman, all of Hooversville, Pa.

LEBANON, PA.—The Lebanon Electric Light & Power Company has been chartered with a capital stock of $10,000 by Daniel Weaver, J. S. Weaver, Jacob Weaver and Raymond S. Bicksler.

PHILADELPHIA, PA.—The Standard Gas & Electric Company has been chartered with a capital stock of $24,000,000 by Joseph P. Murray and Edgar E. McWhithy, of Philadelphia, Pa. The company proposes to generate and distribute electricity for lamps, heat and motors.

PHILADELPHIA, PA.—The Philadelphia & Suburban Elevated Railroad Company has been chartered to construct elevated railroads on Twelfth and Thirteenth streets; also a subway under North Street, from Filbert to York Street, with three elevated spurs extending to Frankford, Wayne Junction and Strawberry Mansion. S. S. Neff is president.

PITTSBURGH, PA.—Charters have been granted to the Gilpin Electric Company, the Kiskiminetas Electric Company, and the Parks Electric Company. Each company is capitalized at $5,000, and the directors are: George M. Hosack, 1415 Park Building, Pittsburgh, Pa.; treasurer, M. J. Hosack, of Wilkinsburg, Pa.; E. B. Hartman, Jr., of Pittsburgh, Pa., and W. D. McBryar, of Elizabeth, Pa.

CHARLESTON, S. C.—The Charleston Consolidated Railway & Lighting Company has filed articles of incorporation with the Secretary of State with a capital stock of $2,000,000. The company proposes to operate street cars and sell electricity and gas in the city and county of Charleston and operate steamboats to Mount Pleasant and cars from the Isle of Palms. It is understood that the new company will lease the property of the Charleston Consolidated Railway, Gas & Electric Company. The directors are: Julian Mitchell, P. H. Gadsden and F. H. Horlbech.

FLORENCE, S. C.—The Florence Electric & Water Company has been granted a charter by the Secretary of State. The company is capitalized at $100,000 and proposes to operate electric light plants and water works systems. P. A. Wilcox and J. S. Mitchell are incorporators.

GREENVILLE, S. C.—The Greenville Light & Heating Company has been organized with a capital stock of $10,000 by C. M. Bauskett, president and treasurer; J. P. Carlisle, vice-president, and B. S. Harris, secretary.

BRAZIL (R. F. D., TRENTON), TENN.—The Brazil Telephone Company has been incorporated with a capital stock of $2,000 by J. T. Allen, J. W. Burt, J. M. Harris, B. M. Dinwiddie and others.

COOKEVILLE, TENN.—The Cookeville Home Telephone Company has been incorporated with a capital stock of $5,000 by V. E. Bookman, J. T. Shirley, W. C. Maxwell, S. D. Davis and others.

ABILENE, TEX.—Articles of incorporation have been filed for the Abilene Independent Telephone & Telegraph Company by Stanley A. Jones, of Chicago, Ill.; Henry L. Sittle, Richard T. Shelton, Xenophone P. Wilfley and William T. Nardin, all of St. Louis, Mo. The company is capitalized at $300,000 and will take over the property of the Abilene Telephone Company and operate as an independent company.

COALVILLE, UTAH.—The Coalville Water & Power Company has been chartered with a capital stock of $30,000. The company owns the water system in Coalville and holds a franchise to install an electric system in Coalville. The officers are: T. J. Lewis, president; William Boyer, vice-president, and George Beard, secretary and treasurer.

GUNNISON, UTAH.—Articles of incorporation have been filed for the Gunnison Valley Power Company, with a capital stock of $50,000. The company is erecting a power plant on Six-Mile Creek, where it is estimated that a minimum of 400 hp can be developed. The company proposes to furnish electricity for lamps and motors in Gunnison, Centerfield, Mayfield, Sterling, Axtel and other towns and villages in this vicinity. The officers are: M. Beauregard, president; S. M. Dugins, vice-president, treasurer and manager, and L. W. Roush, secretary and engineer.

NEW CASTLE, UTAH.—The New Castle Telephone Company has been chartered, with a capital stock of $5,000. The officers of the company are T. W. Jones, president; John Tullis, vice-president, and R. M. Gillis, secretary and treasurer.

GRAHAM, VA.—The Graham Water & Electric Company has been organized with a capital stock of $25,000. V. I. Sexton is president of the company.

OLYMPIA, WASH.—The Maryhill & Goldendale Railway Company has been incorporated with a capital stock of $10,000 by Samuel Hill, A. E. Hanford, H. C. Richardson and N. D. Miller.

PORT TOWNSEND, WASH.—The Olympic Power & Development Company has been incorporated with a capital stock of $250,000 by E. A. Sims, of Port Townsend, Wash.; Eric Molander, of Everet, Wash.; James H. Causten, James A. Calvert and William B. Martin, of Seattle, Wash. The company proposes to supply Port Townsend and Irondale with electricity and water from the Dungeness, Quilcene and Dosewallips rivers, and also to operate an interurban railway between the two places.

REPUBLIC, WASH.—Articles of incorporation have been filed for the North Washington Power Company, with a capital stock of $20,000, by L. W. Anderson and others.

VANCOUVER, WASH.—The Yakima-Pasco Power Company has been incorporated with a capital stock of $3,000,000 by Lewis A. McArthur, Guy Talbot, N. A. Weathers and James P. Stapleton.

WALLA WALLA, WASH.—The Walla Walla Railway Company has been incorporated, with a capital stock of $500,000, by Lewis A. McArthur and others. The company proposes to construct an electric railway from Walla Walla, Wash., to Milton, Ore.

NELSON, B. C., CAN.—The International Electric Company, Ltd., has been incorporated with a capital stock of $1,000,000 for the purpose of constructing a hydroelectric power plant at the junction of the Salmon and Pend d'Oreille rivers.

Personal.

DR. ALEXANDER GRAHAM BELL will sail from New York on May 20 for a trip around the world.

MR. B. T. LONGINO, formerly with the Seattle Electric Company, has been made assistant superintendent of the Tacoma Railway & Power Company.

MR. THOMAS A. EDISON has an article on "The To-morrows of Electricity and Invention" in *Popular Electricity* for June. The article is illustrated by some unpublished portraits of Mr. Edison.

MR. ERNESTO LIX-KLETT, a graduate of Cornell University in the Class of 1908, is assistant electrical engineer of the Rio de Janeiro (Brazil) Tramway, Light & Power Company, engaged in the erection of a 10,000-kw, 88,000-volt substation.

MR. JAMES K. WASS, who has been auditor of the Bell Telephone Company at St. Louis for the past seven years, was the guest of honor recently at a dinner given to celebrate the twenty-fourth anniversary of his continuous service with the company.

MR. M. F. CLEMENT presented a paper dealing with hydroelectric development at Barre Falls and the transmission of energy to an industrial plant at a meeting of the Worcester Polytechnic Institute Branch of the American Institute of Electrical Engineers.

MR. E. H. LE TOURNEAU, formerly connected with the electrical testing department of the New York Central & Hudson River Railroad Company, has become manager of the electrical equipment of the Exchequer Gold Mining Company, Exchequer, Cal.

MR. H. P. HILL has resigned as president and withdrawn from the Hill-Hupfel Engineering Company. Mr. W. H. Fricke has been elected president to succeed Mr. Hill, who will continue at 30 Church Street, New York, in the gas-producer, engineering and complete electrical installation business.

MR. ED. QUILLEN, who has been in charge of the new business department of the Montgomery (Ala.) Light & Water Power Company, for Henry L. Doherty & Company, has been transferred to a similar position with the Easton (Pa.) Power Company. Mr. D. M. Coughlin, who was formerly in charge of this work at Easton, has been transferred to the Spokane (Wash.) Gas Company.

MR. F. W. SINRAM, secretary and manager of sales of the "Long-Arm" System Company, Cleveland, Ohio, and for many years connected with the Adams-Bagnall Electric Company, has tendered his resignation, to take effect June 1, 1910, in order to take an active interest in the Van Dorn & Dutton Company, also of Cleveland, with which he will be connected in a similar capacity.

H. W. ZIMMERMAN & COMPANY, of Chicago, have been retained

by the Merriam investigating committee of the Chicago City Council for making an investigation and report on the methods and equipment of the electrical department of the city of Chicago. The commission has been investigating all of the city departments with a view to securing greater efficiency and locating sources of loss in the city machinery of administration. Under the electric department in Chicago come all of the street lighting, whether gas or electricity, the fire-alarm and police telegraph systems and the electrical inspection bureau.

MR. EDWIN E. DOWNS, vice-president and general manager of the Lee County Lighting Company, of Dixon, Ill., has resigned, to become general manager of the Chicago & Milwaukee Electric Railroad Company, with offices at Chicago and Highwood, Ill. Mr. Downs, who is an old Thomson-Houston man, has had extended experience in the electrical field, particularly with electric railways.

MR. S. N. KATOGI, editor and proprietor of the *Denki no Tomo,* or *Electrical Friend,* published in Tokyo, Japan, is a member of the party of Japanese editors, financiers and merchants who are making a tour of the world under the patronage of the *Ashi Shimbun,* one of the leading daily newspapers of Japan. Mr. Katogi is also secretary of the Japanese Electrical Society, which now has a membership of 1500. For two years, from 1889 to 1891, Mr. Katogi studied the American telephone system in the office of Mr. J. J. Carty. He is a member of America's Friend Association and was a member of the committee which in 1901 erected a statue to Commodore Perry and of the reception committee upon the occasion of the visit of the American battleship fleet to Yokohama a few years ago.

Obituary.

MR. JOHN E. McKAY, for more than 40 years connected with the Department of Water Supply, Gas and Electricity of the City of New York, died at his home in White Plains on May 12 in his seventy-fifth year.

MR. ABEL WHEELER, who was instrumental in forming the Lowell (Mass.) Electric Light Company and was for a time treasurer of the Consolidated Electric Light Company of Maine, died in Lowell on May 9, in his sixty-seventh year.

Trade Publications.

GRATES.—Catalog B, of the Kelly Foundry & Machine Company, Goshen, Ind., describes and illustrates rocking, dumping, stationary and portable grates.

LUBRICANT.—A folder with a return post card perforated in one corner is being sent out by Adam Cook's Sons, New York, advertising the superior qualities of Albany Grease.

DYNAMOS AND MOTORS.—A line of small direct-current generators, motors and motor-generators is described and illustrated in Bulletin 182, of Roth Bros. & Company, Chicago, Ill.

DUPLEX STEAM PUMPS.—The design and construction of a line of duplex steam pumps for general service are discussed and illustrated in Bulletin 35, of the Jeanesville Iron Works Company, Hazelton, Pa.

POLES.—A booklet issued by the W. C. Sterling & Son Company, of Monroe, Mich., gives an interesting account of the cedar pole industry, together with specifications, weights, dimensions, etc., of standard transmission poles.

BOLT-THREADING MACHINES.—The construction and application of multiple automatic die heads in bolt-threading machines are described and illustrated in Catalog 46 of the Newton Machine Tool Works, of Philadelphia, Pa.

INSULATOR SUPPORTS.—A line of universal insulator supports, designed for use on structural steel of all shapes and which requires no boring of holes, is the subject of a leaflet, 316E, of the Steel City Electric Company, Pittsburgh, Pa.

LARGE ENGINE-DRIVEN DIRECT-CURRENT GENERATORS.—Bulletin 119, of the Crocker-Wheeler Company, Ampere, N. J., describes generators of this type and contains much information which will be useful to any central station man.

ELECTRIC HOISTS.—A 24-page booklet, 4 in. x 9 in., of the Sprague Electric Company, New York, illustrates and describes a line of hoists, specially designed for handling different kinds of material in factories, shipping rooms, coal handling plants, etc.

FANS.—There is a good deal of information on exhaust fans in Bulletin 124, which has recently been published by the Crocker-Wheeler Company, of Ampere, N. J. The conditions peculiar to exhaust fan operation are set forth and their effect on motor design discussed.

INTERCOMMUNICATING TELEPHONE SYSTEM.—The Direct-Line Telephone Company, of New York, has sent out a small folder intended to arouse interest which can be further stimulated by returning a postal card with printed queries on the back, which accompanies the folder.

JUNCTION CUT-OUTS, FUSE BOXES, ETC.—Bulletins 112 and 113 of the D. & W. Fuse Company describe service switches, fuse boxes for national code fuses, transformer and junction cut-out boxes, in sizes up to 1000-amp rating. The company has also issued a supplement to its price list 12-A.

STORAGE BATTERIES ON YACHTS.—Bulletin 122 of the Electric Storage Battery Company, Philadelphia, Pa., describes various battery equipments for lighting yachts and motor boats. Some famous yachts equipped with chloride accumulators are illustrated and the lighting equipment briefly described.

EXHAUST FANS.—The Western Electric Company has just issued Bulletin 5351 on motor-driven exhaust fans. In addition to description and illustrations, there are several useful tables. One table gives the amount of fresh air required per person to maintain a given degree of air purity in rooms of different sizes.

FUSES.—The Chicago Fuse, Wire & Manufacturing Company has just issued a new edition of Catalog 24, in which the dimensions, ratings, price, etc., for various types of fuses and fuse blocks are given. The line of fuses includes cartridge fuses for 2500 and 5000 volts, in standard sizes of from 1 to 60 and 30 amp, respectively.

ARMORED HOSE.—Flexible steel armored hose for compressed air, steam or water, is described in a 28-page booklet, 4 in. x 9 in., published by the Sprague Electric Company, New York. Prices, dimensions and weights of hose and couplings are given, and applications of the hose in drilling, chaining brake tanks, operating air hammers, etc., are illustrated.

FANS.—Ceiling, wall, column and desk fans, equipped with either direct-current or alternating-current motors, are the subject of an attractive 36-page bulletin issued by the Sprague Electric Company, New York. The descriptions of the constructions are accompanied by tables of dimensions, weights, ratings and prices, as well as lists of parts for repair.

CENTRIFUGAL PUMPS.—Single and multi-stage pumps for connection to steam turbines, electric motors or high-speed reciprocating engines are described and illustrated in P. C. Bulletin 30, of the Jeanesville Iron Works Company, Hazelton, Pa. The bulletin contains useful information on power plant economies and gives results of a test on an 8-in. 6-stage pump.

AIR BRAKE VALVES.—Bulletin 388 of the National Brake & Electric Company, Milwaukee, Wis., is devoted to a description of the different types of motorman's valves. The description is made clear by excellent illustrations which clearly show the internal parts and their relation to each other. An ingenious device is a sander operated by a small key, which can be depressed by the thumb without removing the hand from the brake handle.

WORK DONE.—The fourth volume of "Work Done," published by Westinghouse, Church, Kerr & Company, New York, has recently appeared. The book contains 82 pages, 6 in. x 9 in.; it is neatly printed and well illustrated. The book describes the organization and purpose of the company and gives illustrated descriptions of important work recently completed. The work described includes the building of power plants, railways, factories and office buildings.

REFLECTORS FOR TUNGSTEN LAMPS.—A line of glassware, designed especially for tungsten lamps, is the subject of catalog F issued by the Phœnix Glass Company, New York City. Each type of reflector is taken up separately, and the service to which it is adapted is set forth by text, distribution curves, illustrations and tables giving dimensions, prices and ratings. The book has 28 pages, 6 in. x 9 in., and is bound in a very attractive paper cover.

"BLOWER EQUIPMENT FOR THE MODERN FOUNDRY."—The American Blower Company, Detroit, Mich., has issued, with this title, a handsome pamphlet which embodies a treatise on foundry heating and ventilation by Mr. F. R. Still. A section is devoted to the driving of cupola blowers by direct-connected electric motors. A comparison is given of the cost of generating electricity by isolated electric light and power plants, with the purchase of current from central stations.

SMALL ENGINE TYPE DIRECT-CURRENT GENERATORS.—Bulletin 121, of the Crocker-Wheeler Company, Ampere, N. J., describes a type of generator designed for isolated plants, and contains much useful information regarding their design. It is stated that, where boilers are used for heating a building, the isolated plant is often the most economical solution of the power problem. The additional power required to drive the generators over that required for the heating system may often be secured with only a slight increase of the winter's coal pile.

REINFORCED POLES.—The Pittsburgh Reinforcing Pole Company, Pittsburgh, Pa., which controls the Orr reinforcing process, has issued a report of tests made on poles at the East Liberty yard of the Allegheny County Light Company which are of interest. It is claimed that about 90 per cent of discarded wooden poles are cast aside for reason of decay at the ground, although they are strong enough above ground to give many years additional service, if some substantial method were had to repair the decayed butt. The Orr reinforcing process, which employs steel rods and concrete at the weakened portion of the pole after all decayed wood has been removed, is claimed to give a new lease of life to such poles, and the tests given in the pamphlet would appear to bear out the contention of the manufacturer on this point.

ARC LAMPS FOR INTERIOR LIGHTING.—An enclosed direct-current arc for use in multiple circuits is described in Bulletin 5500-I of the Western Electric Company. This lamp has a very cleverly designed feeding mechanism, which is claimed to give excellent results as regards continuity and uniformity of the light. The upper electrode consists of two carbon pencils inserted in brass tubes inclined toward each other,

while the lower electrode is larger and is controlled by solenoids. The upper carbons meet at the vertex of the angle and the weight which presses them together is so arranged that one carbon cannot feed faster than the other; therefore, the position of the upper crater is fixed in space. The lower carbon draws the arc and is held at the proper position by the controlling magnets. The clutch which operates the lower carbon does not touch the carbon, but grasps a smooth brass rod to which the carbon is fastened.

REGULATING POLE ROTARY CONVERTERS.—The extensive use of rotary converters, particularly in connection with electric lighting and industrial power plants, frequently necessitates a variable ratio between the alternating and direct current voltages for charging storage batteries and compensating for line drop as well as for numerous other special requirements. To simplify the wiring arrangements and reduce the cost of auxiliary devices, the General Electric Company has developed a line of regulating pole rotary converters. These converters are adapted for a variety of purposes where a variable conversion ratio is required either to maintain constant direct current voltage with varying alternating current voltage, or to vary the direct current voltage as required. They are built in capacities of from 300 to 3000 kw, with a voltage range between 240 and 300, to cover the usual lighting circuit requirements. Bulletin No. 4723 of the General Electric Company describes and illustrates this line of converters.

BUSINESS NOTES.

THE METROPOLITAN SWITCHBOARD COMPANY has moved its factory to East Avenue and Fourteenth Street, Long Island City, New York.

ROBERT WETHERILL & COMPANY, manufacturers of Corliss engines, boilers, etc., Chester, Pa., have opened a New York office at Room 2053, Hudson Terminal Building, 50 Church Street, in charge of Mr. Robert Wetherill, Jr.

THE AMERICAN CONDUIT MANUFACTURING COMPANY, Pittsburgh, has appointed Mr. Fred W. Nason, 39 Cortlandt Street, New York, to look out for its interests in the Metropolitan District. Mr. Nason succeeds Mr. C. V. Gilpin.

THE DONGAN ELECTRIC MANUFACTURING COMPANY, of Albany, N. Y., announces the establishment of a branch office at 113-15 Third Avenue South, Seattle, Wash. The company manufactures a complete line of switchboard and portable instruments for all classes of service.

AMERICAN OPTICAL COMPANY'S POWER PLANT EXPANSION.—The American Optical Company, Southbridge, Mass., has decided to add two Diesel engines of 500 hp combined rating to its power plant, with a dynamo of the same capacity. The original installation was planned for 1000 hp and the equipment is being erected in a new power house. The company will shortly shut down its water wheel service and disconnect an existing steam unit in favor of oil engines.

GARWOOD ELECTRIC COMPANY, of Garwood, N. J., reports having taken a number of orders during the month of April, including one for three 300-kw direct-current generators, a 150-kw generator and 37.5 kw in balancer sets, to be installed in the New Whitehall Building, which, when completed, will be the largest building in the world. The company has also sold four 150-kw, 250-volt generators to the Brewster Company, of Long Island City, and several slow-speed motors for ventilating purposes to the Institute of Music, New York City.

LARGE ORDER FOR "DIAMOND" LEAD-ENCASED CABLE.—The Diamond Rubber Company, Akron, Ohio, has received an order covering over six miles of "Diamond" lead-encased multiple conductor cable, which is to be used for fire control service in the Signal Corps of the United States Army. Part of the order has been shipped to New York, another part to California, and still another part to Hawaii. In the army inspection the tests showed that the cables not only met the United States Government specifications, which are the most rigid in the world, but considerably exceeded them.

THE VIVAX STORAGE BATTERY COMPANY on May 1 succeeded the Chicaro Storage Battery Company in the manufacture of the "DurO" line of storage batteries for automobile ignition and lighting. Mr. W. R. Gibbs, for years the president and general manager of the "DurO" battery, has decided to make his home in the East, where he has large business interests, his withdrawal deciding the directors to accept a plan, which has for some months been considered, to amalgamate the "DurO" and "Vivax" factories under one roof and management. Mr. Horace W. Beek, as manager of the Vivax company, will be strengthened by this combination—the "Vivax" and "DurO" forces working together to produce the best possible results in battery manufacture.

STERN-BAKELITE AND STERNOID.—The Dickinson Manufacturing Company, Springfield, Mass., is now manufacturing several new insulating materials under processes originated by Kurt R. Sternberg, general manager and treasurer of the company. One of these is known as "Sternoid," which is said to be the first insulating material produced in this country which combines the properties of being heat proof, of high dielectric and mechanical strength, which can be molded and into which metal parts can be embedded while molding. The insulation is waterproof and is acid proof for all practical purposes. The firm is also manufacturing an insulation named Stern-Bakelite, the binder of which consists of Bakelite, the invention of Dr. L. H. Baekeland, of Yonkers.

THE OHIO BRASS COMPANY, of Mansfield, Ohio, announces that it recently purchased a controlling interest in the Insulator Pottery, at Barberton, which for the past two years has been making the O-B Hi-Tension Porcelain Insulators sold exclusively by it. Active management of the Insulator Pottery has been taken over by the officers of the Ohio Brass Company, and under the new arrangement the company, with Mr. G. A. Mead, previously chief engineer of the Ohio Brass Company, in active charge at the pottery, expects to put into effect a system that will increase the rate of production materially, thus keeping pace with the great amount of business being received. All orders and inquiries will be handled from the main office of the Ohio Brass Company, at Mansfield, Ohio, as heretofore.

RECORD ORDERS FOR GARTON-DANIELS LIGHTNING ARRESTERS.—The Cleveland Electric Illuminating Company has recently placed an order with the Electric Service Supplies Company, Philadelphia, for 2200 Garton-Daniels lightning arresters for use on its 2500-volt distribution system, which order is believed to be the largest single order for arresters ever placed at one time with any one company. The following list is an indication of the success with which Garton-Daniels arresters have operated on the lines of this company, its purchases having been as follows: 1905, 1; 1906, 175; 1907, 425; 1908, 215; 1909, 275; 1910, 2250. The first purchase in 1905 called for a single arrester for laboratory and service tests. Out of a total of 3341 Garton-Daniels arresters which this company now has on its lines, about 70 per cent, or 2451 in number, are C. E. 2500-volt wood-covered pole type. The makers of the Garton-Daniels lightning arrester point to the final order of 2200 as leaving no doubt as to the real and permanent satisfaction which attends the use of these devices.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED MAY 10, 1910.

[Conducted by W. F. Bissing, Patent Law, 2 Rector St., N. Y. City.]

957,192. ELECTRIC BATTERY; F. A. Decker, Philadelphia. Pa. App. filed June 20, 1907. For supplying fluid from a supply tank to a plurality of batteries and at the same time reciprocating the batteries for the purpose of irrigation or changing the fluid.

957,193. PROCESS OF PREVENTING SURFACE OXIDATION OF RESISTANCE-CONDUCTORS; J. T. H. Dempster, Schenectady, N. Y. App. filed March 20, 1909. Applies to the conductors a readily oxidizable substance of carbon, so as to form a protecting coating.

957,209. ELECTRIC GENERATOR AND MOTOR; C. T. Hibbard, Minneapolis, Minn. App. filed July 24, 1908. For securing the pole pieces to a spider, the rim having orifices and the pole pieces having laminated tongues fitting therein.

957,213. COIL FOR ELECTRICAL PURPOSES; E. W. Jodrey, Lynn, Mass. App. filed Oct. 26, 1905. The coil support is made of tubular fibrous insulating material, and terminal conductors are stapled to the support with a conductor coiled about it and its terminals secured to the conductors.

957,223. DEVICE FOR OPERATING MOTORS FOR SEWING-MACHINES AND THE LIKE; W. Lenhart, Cuyahoga Falls, Ohio. App. filed Dec. 31, 1909. Operated by the knee to work a pivoted lever to throw a friction wheel in and out, and also to apply the brake.

957,226. ELECTRIC HEATER; J. C. Logan, Pittsfield, Mass. App. filed Mar. 30, 1909. Comprises two annular spaced rings of insulation having two independent resistance conductors wound thereon adjacent to each other and three terminals, one common to both windings.

957,227. ELECTROPNEUMATIC AIR BRAKE SYSTEM; G. MaCloskie, Schenectady, N. Y. App. filed Feb. 1, 1910. An electromagnet varies the amount of pressure on opposite sides of the movable member subjected on one side to brake cylinder pressure.

957,242. DYNAMO ELECTRIC MACHINE; J. E. Noeggerath, Schenectady, N. Y. App. filed Apr. 13, 1908. A generator without moving parts in which the flow of water through a pipe with a narrow opening passing through a magnetic field produces the electric current.

957,249. DYNAMO ELECTRIC MACHINE; W. D. Pomeroy, Norwood, Ohio. App. filed May 3, 1906. Field magnets with ventilated coils which are divided into sections by ribbed collars.

957,256. ELECTRIC SOLDERING-IRON; E. W. Rice, Jr., Schenectady, N. Y. App. filed Oct. 7, 1909. An electrically heated soldering tip and a handle therefor composed of an elongated coiled spring.

957,261. ATTACHING-PLUG; H. R. Sargent, Schenectady, N. Y. App. filed Oct. 1, 1907. An attaching plug having a recessed body divided into two chambers, a line terminal in each chamber and a removable enclosed fuse in each chamber.

957,262. INTERLOCKING SWITCH; A. C. Savage, Schenectady, N. Y. App. filed Jan. 28, 1909. Operated by electro-magnetically operated switches, the movable contact of the switch being yieldingly mounted to slide longitudinally along an actuating member, which has a combined longitudinal and sidewise movement, first producing an abutting engagement and then a wiping contact.

957,279. FLEXIBLE DRIVING CONNECTION; S. M. Vauclain, Philadelphia, Pa. App. filed Mar. 24, 1909. The motor frame is spring supported, being mounted on the axle and carries a driving

shaft which carries a crank, there being another crank on the axle and a third crankshaft mounted in a yielding bearing with rods connecting the cranks.

957,289. SHAFT-OSCILLATOR; A. H. Wouters, Norwood, Ohio. App. filed Mar. 6, 1907. Periodically applies fluid pressure against one end of the shaft.

957,290. DIRECT CURRENT TURBO-GENERATOR; E. C. Wright, Newport, Ky. App. filed Nov. 30, 1906. Secures and retains in position rings for the portion of the coils which projects beyond the ends of the cores by putting the rings on when hot and allowing them to contract.

957,312. TELEGRAPHIC KEYBOARD TRANSMITTING APPARATUS; P. B. Delany, South Orange, N. J. App. filed Feb. 5, 1906. The signal to be made is formed by closing the required

957,256—Electric Soldering Iron.

branches to the signal circuit in advance of the actuation of the controlling device which has a trailer traversing a series of contacts to each of which a circuit is connected.

957,319. CIRCUIT BREAKER RETARDING DEVICE; C. E. Eveleth, Schenectady, N. Y. App. filed May 25, 1904. A time-limit device, including a fluid reservoir with a yielding wall, a leak valve and means for adjusting the leak valve to vary the size of the opening.

957,321. BATTERY CHARGING AND DISCHARGING SYSTEM; L. Fiedler, Stoke Newington, London, England. App. filed Feb. 25, 1907. For secondary batteries in which the charging and discharging is controlled by switches actuated by solenoids, one of which is short circuited when the accumulator is charged and the charging circuit opened.

957,334. CIRCUIT BREAKER; C. T. Henderson, Milwaukee, Wis. App. filed July 1, 1909. An electro responsive circuit controlling switch, a switch responsive to abnormal conditions for de-energizing it, and an interlock between the switches preventing the second switch from returning when the first is open.

957,335. AUTOMATIC CIRCUIT-BREAKER; C. T. Hentschel, Schenectady, N. Y. App. filed Sept. 10, 1908. Improvements on an overload switch operated by a disengagable connection between the contacts and the handle and a trip coil actuating the connection when an attempt is made to close while an overload exists.

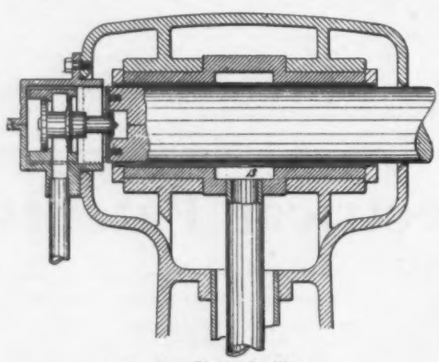
957,337. ELECTRIC FURNACE; H. W. Hixon, Philadelphia, Pa. App. filed June 11, 1909. The furnace casing is non-conducting, and upper and lower electrodes are arranged therewithin, and the vapor density of the zinc is maintained during the charging operation.

957,371. ATTACHMENT FOR ELECTRIC LAMP SOCKETS; H. E. Plunkett, Charlestown, Mass. App. filed May 17, 1909. Improved attachment for the switch-operating mechanism of electric lamp sockets to hold the chain by means of a wire arm out of the way of the shade or globe.

957,403. TELEPHONE RECEIVER; N. Baldwin, Heber, Utah. App. filed July 1, 1909. A casing containing a field magnet on which a disc is mounted with a non-magnetic metallic spool for the winding having a slot in one side and a cap for clamping the disk against the casing.

957,404. TELEPHONE MOUTHPIECE; A. Bebout, St. Louis, Mo. App. filed Mar. 29, 1909. A removable device for preventing contagion, consisting of an annular frame with inner and outer walls and a space between, the outer wall fitting over the mouthpiece of one diameter and the inner over a mouthpiece of smaller diameter.

957,452. AUTOMATIC CIRCUIT CONTROLLING DEVICE; W. C.



957,289—Shaft Oscillator.

Yates and W. O. Lum, Schenectady, N. Y. App. filed Sept. 22, 1906. Motor control by means of electromagnetic switches with cut-out sections of resistance, the switches being controlled by a master controller normally biased to running position.

957,454. MOTOR CONTROL; E. F. W. Alexanderson, Schenectady, N. Y. App. filed Aug. 10, 1907. For controlling alternating current series motors on a car or locomotive, a plurality of them being connected in series with connections for producing a phase displacement between the voltages at the armature terminals of the motors and for impressing on the field a shunt voltage corresponding to the displacement.

957,485. WIRE CLIP; O. A. Beliveau, St. Paul, Minn. App. filed June 22, 1908. For connecting the ends of cable wires with individual circuit wires by means of a base plate carrying a permanently connected bar projecting therefrom and a spring arm.

957,489. TELEPHONE APPARATUS; C. F. Bradburn, Delmer, Ontario, Canada. App. filed Aug. 10, 1907. Selecting mechanism, including primary mechanism, such as a dial and pointer and secondary mechanism with a selecting circuit normally without current, closed through the primary and secondary mechanism of all the stations and an individual selecting battery for each selecting instrument, which is cut in by the primary mechanism.

957,490. TELEPHONE APPARATUS; C. F. Bradburn, Delmer, Ontario, Canada. App. filed Jan. 20, 1908. A selecting instrument having a primary pointer and contacts engaged thereby and a secondary mechanism controlled by the contacts having a secondary pointer and a locking mechanism for the primary pointer controlled by the secondary pointer.

957,491. TELEPHONE SYSTEM; C. F. Bradburn, Delmer, Ontario, Canada. App. filed Nov. 25, 1908. Means whereby any station may simultaneously communicate with the remaining stations, especially for bulletin and concert work and train dispatching by telephone, including a primary and secondary selecting mechanism with relay, emergency switch and suitable connections.

957,505. ALTERNATING CURRENT MOTOR; V. A. Fynn, London, England. App. filed June 12, 1909. An alternating current motor having a stationary neutralizing winding, a rotor with a commuted winding in series therewith, with means for short circuiting the brushes at starting and an exciting circuit produced by closing the circuit of the commuted winding.

957,506. ELECTRIC CABLE; Roderic F. Hall, East Orange, N. J. App. filed July 24, 1905. Made up of insulated wires twisted in pairs, the several pairs being transposed at intervals.

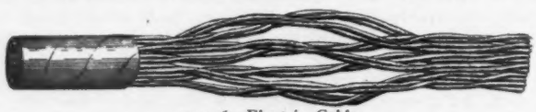
957,523. ELECTRICAL SYSTEM OF DISTRIBUTION; W. A. Turbayne, Lancaster, N. Y. App. filed Sept. 14, 1906. For regulating a storage battery in an alternating current system of distribution by means of a booster, including an alternating current synchronous motor, an induction motor of less poles, with means for varying the latter's speed responding to changes in the alternating current circuit.

957,547. ELECTRIC ROSETTE; J. S. Crossley, Syracuse, N. Y. App. filed Oct. 20, 1906. A one-piece porcelain body with a flat base and hollow boss, having a side opening to receive the knot and notches for the conductor ends.

957,578. CIRCUIT MAKE-AND-BREAK DEVICE; J. E. Scovill, Chicago, Ill. App. filed Apr. 26, 1909. A pivotally mounted wheel having four projecting contact arms with two contacts closed by the arms, a rotatable shaft having an arm to rotate the wheel, the wheel carrying pins and a spring being adapted to contact with two of the pins simultaneously.

957,587. STARTING DEVICE FOR ELECTRICAL MOTORS; H. Weichsel, St. Louis, Mo. App. filed June 17, 1908. A rotary contact member rotated by a rotary handle and a stationary member having notches co-operating with the handle with a cam and yielding member for completing the movement of the contact member from one position to the other.

957,662. MEANS FOR OPERATING MASTER CONTROLLERS; E. G. Deucher, Cleveland, Ohio. App. filed July 28, 1909. For



957,506—Electric Cable.

hoisting machines for coal in which a plurality of master controllers are controlled by gearing for simultaneously rotating them, and a duplex hand lever actuates the gearing when moved in one direction.

957,667. APPARATUS FOR ELECTRICALLY HEATING RUNNING WATER; G. and L. Fuller, Bow, London, England, App. filed June 3, 1909. A casing with an inlet and outlet passage containing a plurality of thin platinum plates electrically connected.

957,668. ALTERNATING CURRENT MOTOR; V. A. Fynn, London, England. App. filed Mar. 6, 1909. For starting and controlling the power factor of a single-phase motor having a shunt characteristic, by means of a stationary neutralizing winding, a rotary commuted winding in series therewith and exciting brushes on the revolving member.

957,699. AUTOMATIC RAILWAY SWITCH; A. A. Moore, Detroit, Mich. App. filed May 29, 1909. Mechanically operated means for throwing out the switch point moved by the car passing along the track through a member, which member is locked by an electromagnet.

957,710. ELECTRIC SIGN; E. J. Prindle, East Orange, N. J. App. filed Nov. 24, 1909. An electric sign for forming a moving picture, consisting of lines of lights which are shifted, being mounted on springs to change the picture.

957,714. MAGNETO ELECTRIC GENERATOR; F. I. and B. P. Remy, Anderson, Ind. App. filed Mar. 25, 1909. Pole pieces are provided on opposite sides of the inductor, on the upper portion of which the magnets are mounted.

957,719. ELECTRIC LAMP SOCKET; F. E. Seeley, Bridgeport, Conn. App. filed Oct. 14, 1907. Pole socket for lamps in which the switch spindle extends through two chambers in the insulating base and is operated by a pawl and ratchet mechanism.

957,741. MOTOR STARTER; A. J. Burns, Hegewisch, Ill. App. filed Feb. 12, 1909. Of the no-voltage and overload release type, in which a contact-carrying drum is geared to a handle and a lock-out device prevents movement of the handle when the latter is in off position, with means for automatically releasing the lock-out device.

957,768. PULL SOCKET; G. W. Goodridge, Bridgeport, Conn. App. filed Dec. 15, 1908. Comprises a ratchet member, a spring turning it one way, a tensioning device for the spring, including an abutment engaged by one end of the spring, and a spring friction bearing, in which the abutment is adapted to be rotated.

957,785. ELECTRIC HEATER FOR OIL WELLS; O. B. Linquest, Jamestown, N. Y. App. filed June 29, 1909. For heating oil wells to remove the paraffin deposits by means of a cage containing a plurality of bars on which heating wire, heated electrically, is wound.

957,792. ELECTRIC METER; C. E. J. O'Keenan, St. Cloud, France. App. filed June 28, 1909. Continuous current meter for measuring watts, including a shunt, a sub-shunt and a winding for heating the sub-shunt whose ends are connected to the main conductors.

957,806. REGULATING INCANDESCENT LAMP SOCKET FOR REDUCING THE LIGHT; E. H. Smith, Aberdeen, Wash. App. filed Dec. 7, 1909. For dimming by means of a rotary rheostat ring mounted within the casing of the socket.

957,824. ELECTRICALLY HEATED ROLLER; G. H. Wade, Atlanta, Ga. App. filed Aug. 11, 1909. A roller with recesses in its ends containing electrical heating elements.

957,852. TRANSMITTING SYSTEM FOR SPACE TELEPHONY; V. H. Laughter, Detroit, Mich. App. filed July 10, 1909. A transmitter and receiver are automatically thrown in and out of operation by the operator's voice, the transmitter being a singing arc.

13,114. ELECTRIC SWITCH; E. M. Coffin, Oakland, Cal. App. filed Jan. 17, 1910. Two-button snap switch in which a shaft carries a shifter and coil spring and a controller is provided with side members and a bridge connecting them.